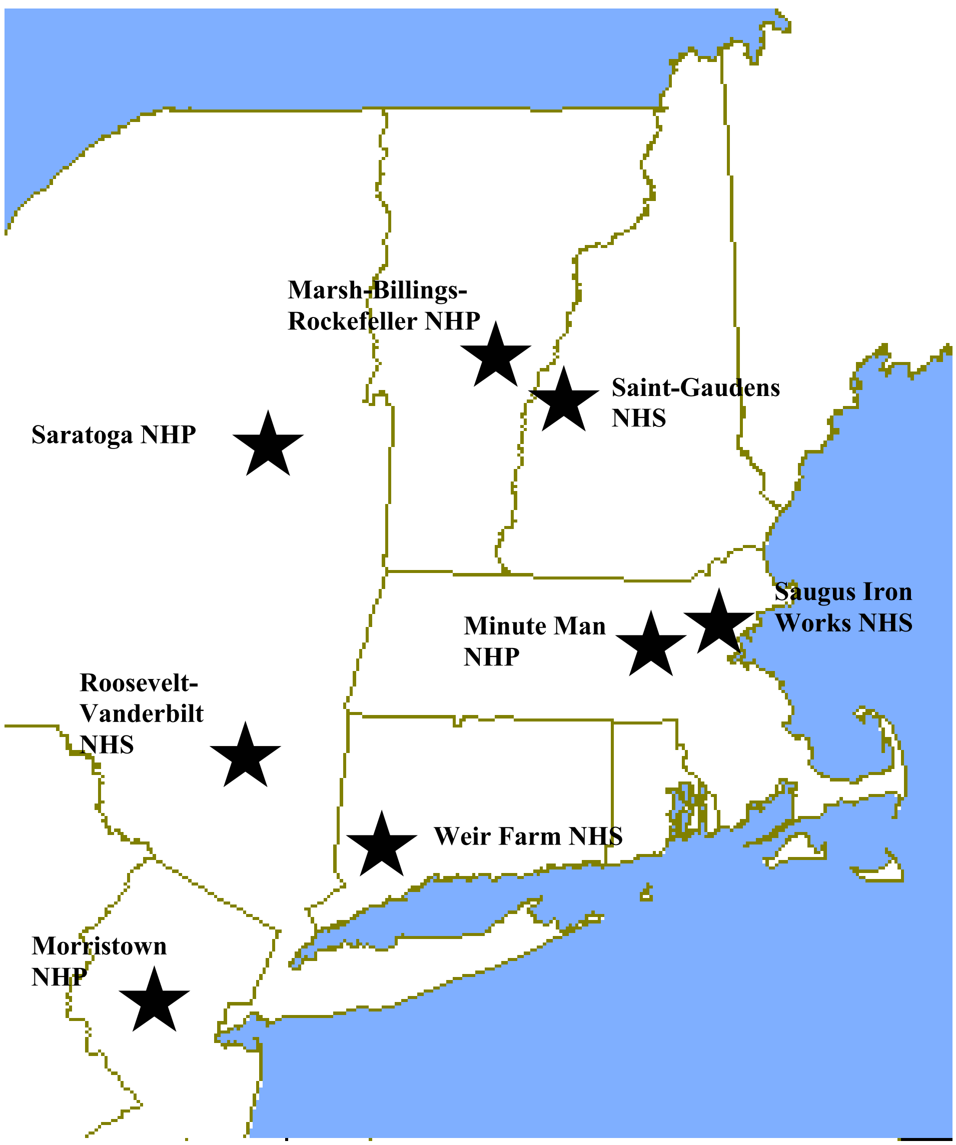
National Park Service
U.S. Department of the Interior

Northeast Region
Inventory & Monitoring Program
Northeast Temperate Network
Woodstock, Vermont

Freshwater Fish Inventory: Northeast Temperate Network, 1999-2001

Technical Report NPS/NER/NRTR—2005/16



ON THE COVER
Northeast Temperate Network parks
Image by Martha Mather

Freshwater Fish Inventory: Northeast Temperate Network, 1999-2001

Technical Report NPS/NER/NRTR—2005/16

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Introduction

Freshwater fish are an important component of aquatic ecosystems by acting as key predators and enhancing trophic diversity. Freshwater fish also provide important recreational opportunities for anglers and have been a principal funding source for aquatic resource conservation through the sale of fishing licenses.

Phase I of the National Park Service (NPS) Inventory & Monitoring (I&M) program involves conducting biological inventories to document occurrence (presence/absence), and under certain circumstances, abundance for vertebrates and vascular plants. This project establishes baseline inventories of freshwater fish for seven National Parks of the Northeast Temperate Network (NETN). Few parks within the network have had research or inventories conducted on freshwater fish creating a gap in our understanding of this resource. Freshwater fish play an important role in aquatic systems of National Parks; knowledge of the fish fauna within the parks will allow park managers to better understand and manage park natural resources.

This freshwater fish inventory was conducted between 1999-2001 at seven NETN parks: Marsh-Billings-Rockefeller-National Historical Park, Minute Man National Historical Park, Morristown National Historical Park, Roosevelt-Vanderbilt National Historic Site, Saint-Gaudens National Historic Site, Saratoga National Historical Park, and Weir Farm National Historic Site (Saugus Iron Works National Historic Site habitats were very different from those at other northeastern parks. A tabulated list of possible freshwater species (12 potential species, 11 native species) from the existing gray literature was done, but no field sampling was done.). The primary goals of this inventory were to address the information gaps related to freshwater fish diversity in these seven parks and document 90% of the fish species present.

Objectives

1) To compile and review existing freshwater fish information for each park.
2) Determine the composition of fish communities in all major habitats within each park

Methods

Sample Site Selection

All aquatic resources were visited in the field and qualitatively identified by habitat type because fish sampling gear works differently in different habitats (Table 1). To select sampling locations, all aquatic habitats were marked on a topographic or GIS map and access points were identified. Habitats were divided into two primary types; standing water (lentic) and flowing water (lotic, Table 1). Sites were selected in standing water habitats by dividing the lake or pond into sections and randomly selecting locations to sample. When access limited the ability to select random sites, we identified representative locations throughout the pond for sampling. For stream habitat we selected 5-10% of each stream habitat type for sampling. We selected sites to ensure that all habitats were represented in the sample.

Table 1. Freshwater habitats definitions and presence in each sampled park.

Habitat Identification		MABI	MIMA	MORR	ROVA	SAGA	SARA	WEFA
Lentic Habitats (standing water)	Low Flow Impoundment: a body of water formed by a man-made dam to form a small pond or lake. The outflow and inflow is generally minimal.	X	X	X	X	X	X	X
	High Flow Impoundment: a body of water formed by a man made dam to form a small pond or lake. The outflow and inflow is substantial.				X	X		
Lotic Habitats (flowing water)	Low Gradient Stream: slower moving, soft bottomed system with many large pools		X	X	X	X	X	
	Moderate Gradient Stream: faster moving, gravel and cobble bottomed system with riffles and runs		X	X	X	X	X	
	High Gradient Stream: extremely fast moving, rock to boulder bottomed system with runs, falls, and plunge pools		X	X	X	X	X	

Sampling Season

Aquatic resources for all parks were sampled from August to November, 2000. Catches will be less variable in the fall and we recommend this for monitoring. Pond sampling can be done day or night. Night time sampling often gives better catches but sometimes this is impractical. If the nets/traps can be set over a dawn or dusk period, catches may be enhanced. If the nets and traps are left in too long, fish mortality may occur so fishing time needs to be monitored. Electrofishing needs to be done in the daytime.

Sampling fish in lotic habitats

For standing water (lakes, ponds, and impoundments), we used a standardized suite of gear that included a combination of fyke nets, minnow traps, and trammel nets. A typical standardized suite of gear included 1-3 fyke nets, 5-15 minnow traps, and if the resource was large enough 1-3 trammel nets (Figures 1 and 2). Under optimal conditions, this standardized suite of gear was set across several representative sites within the pond then repeated on several consecutive days/nights. The standardized suite of gear (fyke nets, minnow traps, trammel net, seine) was set repeatedly through time and space until no new species were caught. Before sampling, three intensities of sampling with different time commitments were proposed for each gear type in each habitat type (Tables 2 and 3). Based on our knowledge of the gear, resources, and time constraints, for monitoring, we used a medium intensity and recommend this level of effort for future monitoring. Specific numbers of each gear type varied with the specific aquatic resource.

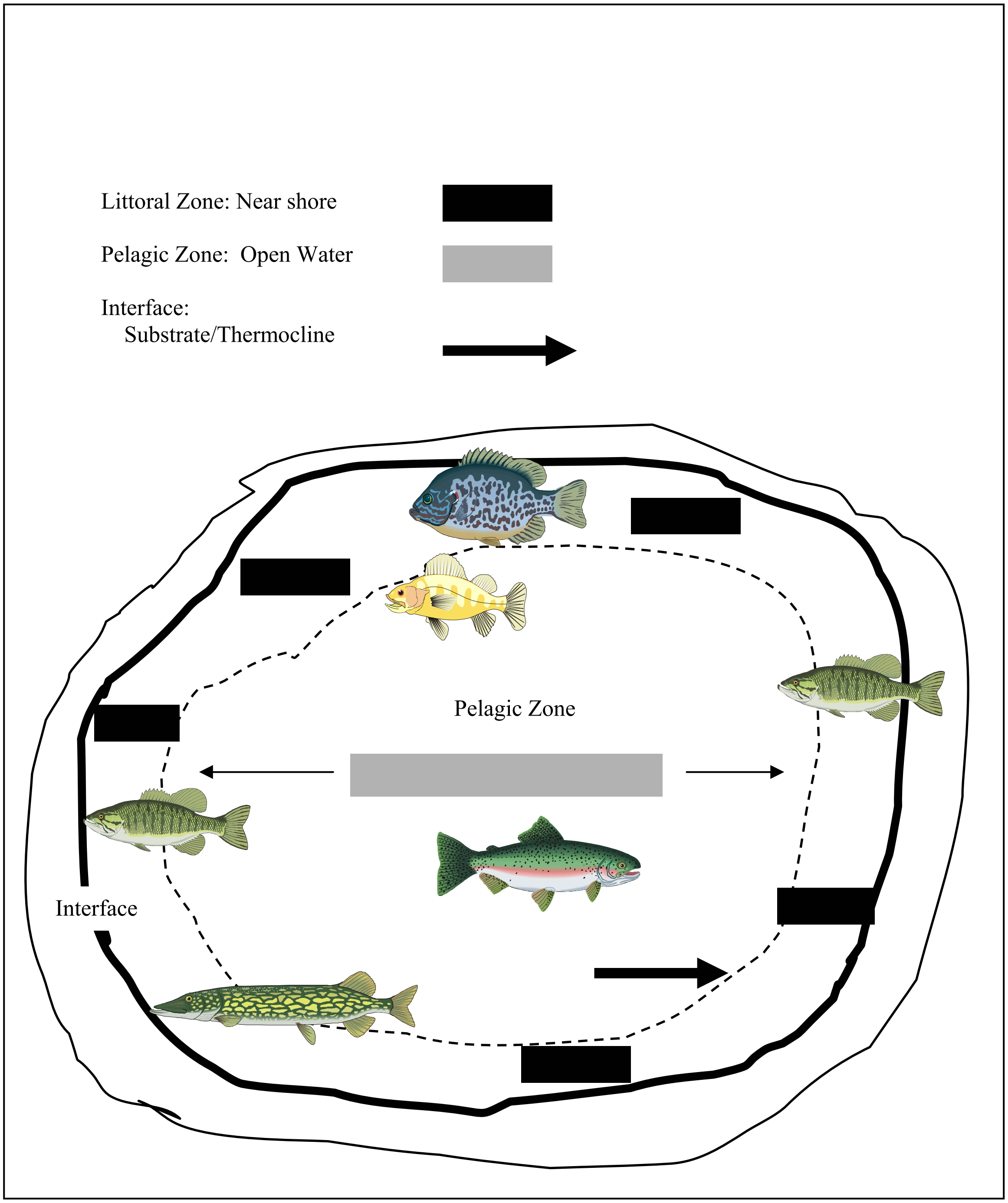

Figure 1. Example of a habitat based sampling program for standing water habitats.

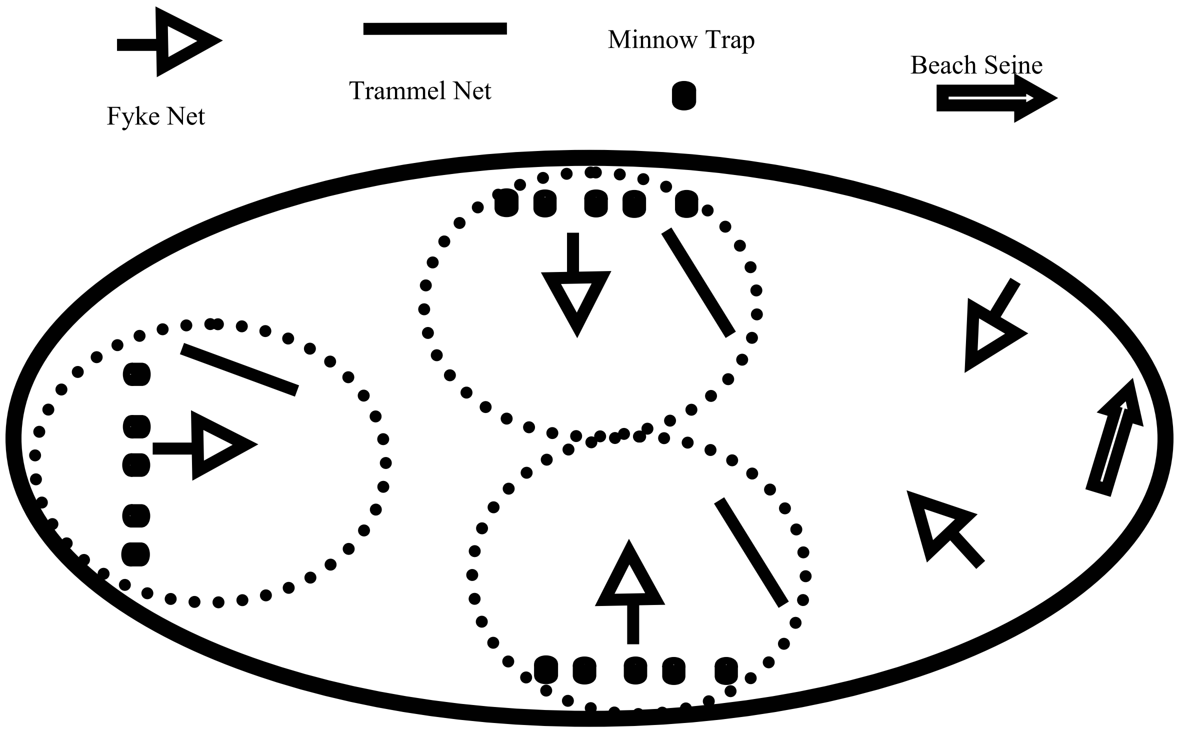

Figure 2. How a standardized suite of gear was set in a pond/impoundment

Table 2. Sampling plan for Lentic Habitats (Low Flow Impoundment and High Flow Impoundment). We chose and recommend a medium effort.

Habitat	Sampling Unit (ideal)	Gear time estimates	High Intensity 4-5 units	Medium Intensity 2-3 units	Low Intensity 1 unit
Low Flow Impoundment	1 Trammel Net	Set time: 15 min./net	1-1.25 hrs.	30-45 min.	15 min.
		Fishing time: 3-4 hrs./net	3-4 hrs.	3-4 hrs.	3-4 hrs.
		Pull time: 10-60+ min./net	50 min. -5+ hrs.	30 min-3 hrs.	10 min-1 hr.
		Total*	2-6.25 hrs.	1-3.75 hrs.	30 min-1.25 hrs.
	1 Fyke Net	Set time: 20 min./net	1.3-1.6 hrs.	40 min.-1 hr.	20 min.
		Fishing time: 7+ hrs./net	7+ hrs.	7+ hrs.	7+ hrs.
		Pull time: 20 min./net	1.3-1.6 hrs.	40 min.-1 hr.	20 min.
		Total*	2.6-3.2 hrs.	1.3-2 hrs.	40 min.
	5 Minnow Traps	Set time: 3 – min./trap	1-1.25 hrs.	30-45 min.	15 min.
		Fishing time: 7+ hrs./trap	7 hrs.	7+ hrs.	7+ hrs.
		Pull time: 5 min ea./trap	1.6-2 hrs.	50min.-1.25 hrs.	25 min.
		Total*	2.6-3.2 hrs.	1.3-2 hrs.	40 min.
	1 Seine (where possible)	Pull time: 15 min.	1-1.25 hrs.	30-45 min.	15 min.
High Flow Impoundment	Trammel Net	Set time: 15 min./net	1-1.25 hrs.	30-45 min.	15 min.
		Fishing time: 3-4 hrs./net	3-4 hrs.	3-4 hrs.	3-4 hrs.
		Pull time: 10-60+ min./net	50 min.-5+ hrs.	30 min-3 hrs.	10 min.-1 hr..
		Total*	2-6.5 hrs.	1-3.75 hrs.	30 min.-1.25 hr.
	Fyke Net	Set time: 20 min./net	1.3-1.6 hrs.	40 min.-1 hr.	20 min.
		Fishing time: 7+ hrs./net	7+ hrs.	7+ hrs.	7+ hrs.
		Pull time: 20 min./net	1.3-1.6 hrs.	40 min.-1 hr.	20 min.
		Total*	2.6-3.2 hrs.	1.3-2 hrs.	40 min.
	Minnow Traps	Set time: 3-min./trap	1-1.25 hrs.	30-45 min.	15 min.
		Fishing time: 7+ hrs./trap	7 hrs.	7+ hrs.	7+ hrs.
		Pull time: 5 min. ea./trap	1.6-2 hrs.	50min.-1.25 hrs.	25 min.
		Total*	2.6-3.2 hrs.	1.3-2 hrs.	40 min.
	Seine (where possible)	Pull time:	1-1.25 hrs.	30-45 min.	15 min.

* Totals include set times and pull times only

Table 3. Sampling plan for Lotic Habitats (low, medium, and high gradient streams/rivers). We chose and recommend a high intensity using option 1.

Habitat	Sampling Gear	Sampling Unit	Intensity		Gear Time Estimates*	
Lower Gradient Stream/River	Backpack electorshocker	25 m- 50 m transect	High Medium Low	4-5 transects 2-3 transects 1 transect	Option 1 Option 2 Option 3	25 m transect (1 Pass): 15 min. 50 m transect (1 Pass): 30 min. 100 m transect (1 Pass): 45 min.
Moderate Gradient Stream/River	Backpack electorshocker	25 m- 50 m transect	High Medium Low	4-5 transects or until graph levels off 2-3 transects or until graph levels off 1 transect or until graph levels off	Option 1 Option 2 Option 3	25 m transect (1 Pass): 15 min. 50 m transect (1 Pass): 30 min. 100 m transect (1 Pass): 45 min.
Higher Gradient Stream/River	Backpack electorshocker	25 m- 50 m transect	High Medium Low	4-5 transects 2-3 transects 1 transect	Option 1 Option 2 Option 3	25 m transect (1 Pass): 15 min. 50 m transect (1 Pass): 30 min. 100 m transect (1 Pass): 45 min.

* Time for processing fish has not been added

Specific deployment protocols for standing water gear

Fyke nets

Fyke nets sample a range of small-medium sized fish in the littoral zone of most lentic habitats (Table 4). Although this gear catches a range of fish sizes and species, the fish must be actively moving such that they hit the lead and are guided into the hoops. The fyke net is typically set four hours before sunset and allowed to fish for eight hours specifically encompassing the dusk time period. To set the nets, move the fyke net and two anchors to the location where the net will be set. Carrying all hoops, place the anchor for the net lead on or close to the shore. Fully extend the lead and net perpendicular to shore by walking or maneuvering the boat in reverse. The front hoop should ideally be set in a meter of water with no more than 1-2 inches above the water surface. Before dropping the anchor, check that the net is tied and the float is in place. After about 8 hours, pull the net. To do this, slowly and carefully approach the front hoop, grab the front anchor, quickly grab either side of the hoop, and quickly scoop the entire hoop out of water. Holding the first hoop, shake fish toward the end compartment. Gather second hoop and shake again. Continue gathering hoops and shaking the net until all fish are in the last compartment. Another person will need to untie the bottom of net, remove the float, and assist the person holding the net by shaking all fish into a live well. Return the float to the net and tie the cod end. Fyke nets can be set in most inshore habitats where the depth increases gradually. Of particular utility for this gear is that the bottom need not be smooth. Fyke nets are low tech and easy to set. Generally, fish and turtles survive long periods (hours) in these nets without mortality especially when a float is placed in the terminal hoop.

Table 4. Gear protocols for Trammel Net, Fyke Net, Minnow Trap, and Beach Seine.

	Trammel Net	Fyke Net	Minnow Trap	Beach Seine
Objective	Sample medium-large fish at the littoral/pelagic interface.	Sample a range of small-medium sized fish in the littoral zone of most lentic habitats	Sample small and young-of-year fish in littoral zone of most lentic habitats	Sample a range of fish, mostly small, fish in littoral zone of most lentic habitats.
Targets/Data gained	The littoral/pelagic interface is surveyed for a variety of fish species and sizes with an emphasis on larger fish	Littoral zone is sampled for a wide variety of species and sizes. Although this catches a range of fish sizes and species, the fish must be actively moving such that they hit the lead and are guided into the hoops. This will not be true for all species.	The littoral zone is sampled with a focus on smaller fish.	The littoral zone is sampled for a range of species and sizes. (Note: large fish often escape.)
Description	Each trammel net is 99 feet long with a wall depth of 4 feet, an outer netting of 12 square inch mesh, and an inner mesh of either: 1 square inch, 1.5 square inch or 2.0 square inch mesh.	The net is 12 feet long with 3 hoops each having a 3-foot diameter. A 3 foot deep by 20 foot long lead extends from the front of the net. Both the lead and trap are made of 3/8 inch mesh.	When clipped together in the center, each cylindrical trap measures 9 inches x 17.5 inches with a 1 inch opening at either end. They are made of ¼ inch galvanized wire mesh.	The seine is 44 feet from pole to pole with a 4 x 4 x4 foot bag in the center and a 1/8 inch mesh size.
Sampling Design	The net will be set for 1.5 hours before sunset and fished for 4 hours. This time period is selected to increase efficiency of net. Three nets, each having a different mesh size, were/can be set simultaneously.	The net is set 4 hours before sunset and allowed to fish for 8 hours, specifically encompassing the dusk time period.	Five traps complement each fyke net at the depth of the first hoop and are set at the same time as the fyke net (4 hours before sunset).	The seine is fished in 33 meter sections. To maximize the effectiveness, transects are done at night.
Recommended Number of People	Two people are necessary in order to complete all aspects of this task.	To set the net without a boat, you will need 1 person. With a boat, you will need 2 people. 2 people are best for pulling the nets.	One person can easily complete this task.	You will need at least two people.
Amount of Gear Set		Number of nets set were resource specific.	15 available traps. Number set was resource specific.	One available net. Number of transects done were resource specific.

Table 4. Gear protocols for Trammel Net, Fyke Net, Minnow Trap, and Beach Seine.

	Trammel Net	Fyke Net	Minnow Trap	Beach Seine
Pros	This (along with gill nets) is one of the few gear to catch this size fish in this habitat.	--This gear can be set n most inshore habitats where the depth increases gradually. Of particular importance is that the bottom need not be smooth. --The gear is pretty low tech and easy to set. --Generally, fish survive long periods in the net especially when a float is placed in the terminal hoop.	--This gear can be set in most inshore habitats. --The gear is low tech, inexpensive, and easy to set. --No boat is needed. --Generally, fish survive long periods (hours) in the traps.	--Low tech, relatively easy to use. --Can produce good catches.
Cons	--This gear doesn't catch some species. --Catches can be variable. --This gear requires a boat and motor and two somewhat skilled workers. --Fish cannot be left in this for too long or they will die.	--This gear doesn't catch some species, and catches can be variable. Hence a number of nets need to be set through time and space. --A stable boat is needed to retrieve the nets.	--This gear doesn't catch some species. --Minnow traps only catch very small fish. --Catches can be variable. Hence a number of traps need to be set through time and space.	--Requires a smooth bottom. --Biased towards small fish.
Setting	1. Make sure the net is packed/folded so it will deploy without tangles. Attach an anchor to one end of the lead line and a float to one end of the float line. 2. Place anchor in approximately 1 meter of water. Then throw float over 3. In order to keep the net perpendicular to the near shore, one person will need to slowly maneuver the boat in reverse toward a fixed point on the other shore line.	1. Move nets and two anchors to location where the net will be set. 2. Carrying all hoops, place anchor for lead on or close to the shore. 3. Fully extend lead and net perpendicular to shore by walking or maneuvering boat in reverse. 4. Front hoop should ideally be set in a meter of water with no more than 1-2 inches above the water surface. 5. Before dropping the anchor,	1. Clip two matching ends together. 2. Attach a floated line to the clip. 3. Set on side in 1 meter of water or a depth equal to the first hoop of the fyke net.	1. Measure out a transect, usually 33 m. 2. Avoid disturbing, i.e. walking through, sit e.

Table 4. Gear protocols for Trammel Net, Fyke Net, Minnow Trap, and Beach Seine.

	Trammel Net	Fyke Net	Minnow Trap	Beach Seine
	(This is why a motor is needed.) 4. As the boat is reversing, the other person will be evenly guiding the lead and float line out the front of the boat. 5. Upon reaching the other end of the net, the driver should stop the boat. The person with the net should attach the other anchor to the lead line and the other float to the float line. 6. Drop the anchor and float overboard	check that net is tied and float is in place.		
Pulling	1. Slowly approach shallow float. Pull in float and anchor. Detach float and anchor before placing net into transport box. 2. One person should man the float line and the other person should man the lead line. 3. Evenly pull in the float and lead lines. 4. Disentangle any fish and place in a live well. 5. Upon reaching other end, pull in and detach deep float and anchor.	1. Slowly and carefully approach front hoop. 2. Grab front anchor. 3. Quickly, place hands on either side of hoop and quickly scoop entire hoop out of water. 4. Holding first hoop, shake fish toward end compartment. 5. Gather second hoop and shake again. 6. Continue gathering hoops and shaking net until all fish are in the last compartment. 7. Another person will need to untie bottom of net, remove the float, and assist the person holding net by shaking all fish into a live well.	1. Pull traps in by float line. 2. Take trap apart. 3. Empty contents into live well.	1. Unwrap net at 0#m and extend net perpendicular to shore <u>making sure that bag is open</u> in correct direction. 2. Pull seine parallel to shore with shallow person maintaining a water depth of a few inches, while the deep person should stay in 1 meter of water. Deep person should remain slightly ahead of shallow person throughout transect and maintain a distance of at least 25 ft. between poles. 3. At end of transect, deep person should move shallower in order to meet the shallow person simultaneously at the 33 m endpoint. <u>Note</u>: If the net gets

Table 4. Gear protocols for Trammel Net, Fyke Net, Minnow Trap, and Beach Seine.

	Trammel Net	Fyke Net	Minnow Trap	Beach Seine
		8. Return float to net and tie.		snagged on rocks or branches, the fish will escape so the bottom must be clear. We recommend clearing a seining path ahead of time. 4. After laying poles on ground, each person should grab a lead line and corresponding float line and evenly pull each end of the net until each reaches the bag. 5. Each person should grab a corner of the bag and decrease the size of the bag by rolling the sides down. 6. Pull all fish out of bag and place into a live well. 7. Shake netting to remove excess debris and compactly roll seine for storage.

Minnow Traps

Minnow traps sample small and young-of-year fish in the littoral or inshore habitat of most lakes, ponds, and impoundments (Table 4). Set the minnow traps on their side in 1 meter of water or a depth equal to the first hoop of the fyke net. After 4-6 h, pull traps in by the float line. Take the trap apart and empty contents into a live well. This gear can be set in most inshore habitats, is low tech, inexpensive, easy to set, and no boat is needed. Generally, fish survive long periods (hours) in the minnow traps without mortality. But this gear doesn't catch some species and only catches very small fish. In addition, catches can be variable. Hence a number of traps need to be set through time and space.

Trammel nets

Trammel nets sample medium to large fish at the littoral/pelagic interface (Table 4). This net will be set for 1.5 hours before sunset and fished for about 4 hours to increase the efficiency of the net. One to three nets, each having a different mesh size, can be set simultaneously.

Beach Seine

The beach seine samples a range of fish, mostly small to medium, in the littoral zone of most standing water habitats (ponds, lakes, and impoundments, Table 4). However, large fish, because they have a sensitive lateral line and strong swimming ability, often escape. The beach seine is fished in 33 meter sections. To maximize the effectiveness, seine transects can be done at night although daytime seining can also catch fish.

A typical sampling routine used to sample standing water was as follows. First the pond/impoundment was scouted and suitable and unsuitable sites for all gear identified. Then suitable locations were selected that sampled the entire resource. While light, all nets and traps were cleaned, dried, and packed for optimal deployment. Fyke nets were stacked with anchors and leads carefully organized. Minnow traps were put together and floats attached. Trammel nets were folded into a carrying tote so that they would go into the water without tangles. About an hour or two before dusk, the fyke and minnow traps were set. To do this, we dropped two people at different sides of the pond where they deployed the fyke and minnow nets on foot. Then, the trammel net was deployed from the boat using at least two samplers. While the nets and traps fish, a beach seine was pulled and fish worked up. After 4-6 h, the trammel net was pulled, fish were processed. Finally, the fyke nets and minnow traps were retrieved and fish worked up. Specific details of deployment are in the protocols tables cited above.

Sampling fish in lentic habitats

We used backpack electrofishing techniques to sample flowing water (streams and rivers). We sampled a 25-m transect during daylight hours in an upstream zigzag pattern, repeated until no new species were caught (Figure 3). We used and recommend option 1

(25 m transect/habitat unit) coupled with a medium to high intensity (2-5 transects) based on our knowledge of the gear, the habitat, and time constraints. How we set the gear and how we recommend others set the gear is outlined in the gear protocols (Table 5).

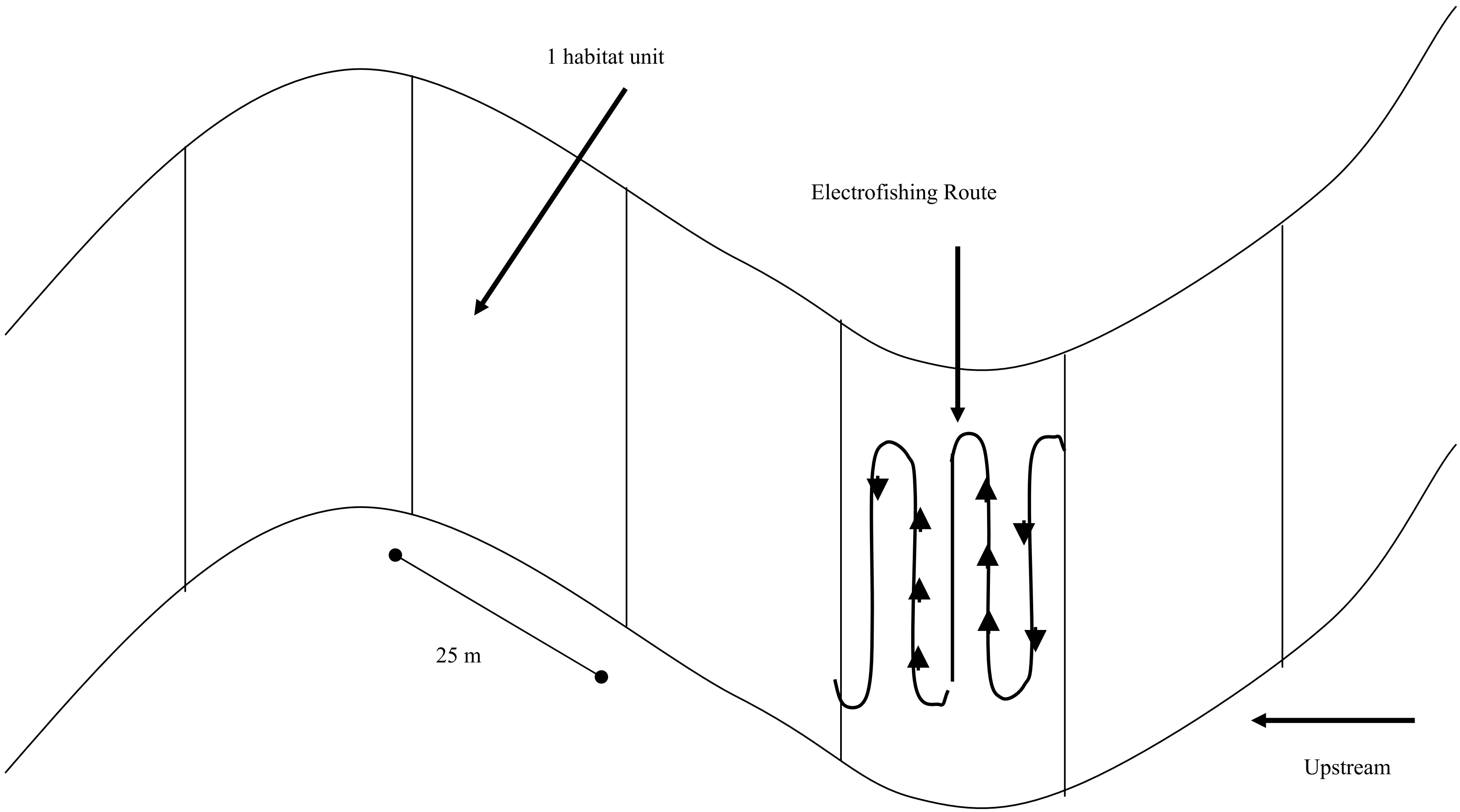

Figure 3. Sampling Layout for Lentic Systems

Table 5. Gear protocols for backpack electroshocker.

	Backpack Electroshocker
Objective	Sample fish in both riffles and shallow pools of most stream habitats.
Targets/Data Gained	The stream is sampled for a range of species and sizes.
Description	Electrical current is used to stun fish. Their muscles are involuntarily attracted to the positive current, then they are stunned when they enter the field.
Sampling Design	A 25 meter reach of stream is sampled by one pass of the electrical field. Once the representative habitats at a given park have been determined, transects are randomly chosen from within a habitat type.
Recommended Number of People	You will need at least 2 people. Electroshocking should never be done alone for safety reasons.
Amount of Gear Set	1 available unit. Number of transects done were resource specific.
Pros	--Only consistent gear for stream sampling --Can produce good catches
Cons	--Can be dangerous to fish and humans --Only works in relatively shallow water --Need to be able to walk safely
Setting	1. Measure transect, typically 25 meters. 2. All participants in electrofishing should be wearing appropriate gear (shock proof chest waders and rubber gloves) 3. Attach cathode and anode to proper locations. 4. Check for correct settings. 5. Assistant should connect battery to unit. 6. Prior to beginning the transect test the unit on a small section of stream.
Pulling	1. With 1-2 assistants each carrying a net and live well (shocker can also carry net), walk diagonally from one side of stream to other side of stream while holding switch in ON position. 2. As fish surface, release button temporarily to net fish and place in live well. Proceed in this manner through remainder of transect. <u>Note</u>: Some fish float when stunned, others sink to the bottom, so watch carefully. 3. At end of transect, if not proceeding directly to next transect, an assistant should disconnect the battery prior to transporting the unit any distance. 4. Next transect must begin at least 10 meters past the endpoint of the previous transect. 5. Process fish after each transect.

Protocols for deployment of specific flowing water gear

Backpack electrofishing samples a range of the fish species and sizes that inhabit riffles and shallow pools. A 25 meter reach of stream is sampled with one upstream serpentine pass of the electrical field. Once the representative habitats at a given park have been determined, transects were randomly chosen from within a habitat type. To prepare a transect, we measured 25 meters along the shore. Backpack electrofishing is the only consistent gear for stream sampling and can produce good catches.

Effectiveness of sampling and sampling units

How we evaluated if our sampling caught 90% of the species is by doing repeated sample standardized units so we could document the number of new species that were caught each time we repeated this standardized effort (Table 6). However, this repetitive standardized sampling is not a useful tool if the standardized unit is not intensive enough to catch a representative sample of fish. Because systems vary in size and difficulty in sampling, the amount of standardized effort that can be meaningful varies. This standardized sampling unit upon which any estimate of variation is based, i.e., N, varies with the sampling goal (monitoring vs research) and with the system but in all sampling the philosophical constructs are the same. For stream sampling, the standardized unit that was repeated was always a 25 m electrofishing transect. By comparing catch in subsequent transects, we could evaluate if new species were being collected and infer when we caught about 90% of existing species. In standing water, for inventory and monitoring, we tried to use a cluster of fyke nets, minnow traps, trammel nets, and seines as a sampling unit that could be repeated elsewhere in the pond. But, because of variability in catch, sometimes we needed to group all gear sampled within a sampling day/night together to get a representative estimate of catch. In this case, the replicate or repeated effort occurred across time, i.e., on several days/nights. For much of the pond inventory and monitoring, we subjectively evaluated if new species were added.

Table 6. Number of habitat units associated with major aquatic resources.

Park	Habitat Type	Habitat Name	STREAM Amount of Habitat (m)	STREAM Total Number of Units	STREAM Units Sampled	STREAM %	POND/IMPOUNDMENT Amount of Habitat (acres)	UNITS OF GEAR	UNITS OF EFFORT	DAYS
WEFA	Lower Flow Impoundment	Weir Pond					3.68	16	88	3
MABI	Lower Flow Impoundment	The Pogue					15	12	82	3
ROVA	Higher Gradient Stream	Crum Elbow	610	24.4	3	12.30				
		Meriches Kill	1067	42.68	12	28.12				
	Lower Gradient Stream	Falkill Creek	1128	45.12	1	2.22				
	Lower Flow Impoundment	Upper Valkill Pond					7	8	57	3
		Lower Valkill Pond					2	0	0	0
	Higher Flow Impoundment	Upper Pond						1	3	1
		Middle Pond						1	1	1
		Lower Pond						0	0	0
		Roosevelt Ice Pond						0	0	
SARA	Higher Gradient Stream	Kroma Kill	2896	115.84	13	11.22				
		Mill Creek	7242	289.68	22	7.59				
		American River			2					
	Low Flow Impoundment	Old Champlain Canal						10	55	3
	Small Lake	Davidsons Farm Pond						2	11	1

Table 6. Number of habitat units associated with major aquatic resources.

			STREAM	STREAM	STREAM	STREAM	POND/IMPOUNDMENT			
Park	Habitat Type	Habitat Name	Amount of Habitat (m)	Total Number of Units	Units Sampled	%	Amount of Habitat (acres)	UNITS OF GEAR	UNITS OF EFFORT	DAYS
	Small Lake	Burdils Farm Pond						2	7	1
SAGA	Higher Gradient Stream	Blow-me-up Brook	1770	70.8	15	21.19				
	Lower Gradient Stream	Blow-me-down Brook	430	17.2	3	17.44				
	Higher Flow Impoundment	Blow-me-down Pond						9	57	2
	Small Lake	Farm Pond						2	16	1
MORR	Lower Gradient Stream	Jersey Brook	457	18.28	2	10.94				
	Moderate Gradient Stream	Primrose Brook	2414	96.56	20	20.71				
		Indian Grave Brook	804	32.16	8	24.88				
		Passaic River	804	32.16	9	27.99				
	Low Flow Impoundment	Cat Swamp Pond						2	20	1
MIMA	Lower Gradient Stream	Elm Brook	748	29.92	3	10.03				
		Mill Brook	2266	90.64	7	7.72				
		Unnamed Brook			2					
	Low Flow Impoundment	Unnamed Pond						4	36	1
		Palumbos Pond						4	36	1
		Folly Pond						1	15	1

Results for Marsh-Billings-Rockefeller National Historical Park

Freshwater Habitat

Marsh-Billings-Rockefeller National Historical Park (MABI) contains one aquatic resource with freshwater fish, The Pogue (Figure 4). The Pogue is a low flow impoundment, or a body of water with a manmade dam that forms a small pond or lake (Figure 5). The inflow and outflow of this type of aquatic resource are minimal but still can act as a source of immigration and emigration for fish and other aquatic organisms. Given the Pogue's location at the top of a hill, a large amount of emigration seems unlikely. Habitats at the Pogue were surveyed in October, 1999. This system was sampled for fish in September, 2000.

Sampling Intensity

During the three days of sampling, 12 sites were sampled representing 82 units of effort (Figure 6). Both day and night sampling were evaluated. The littoral zone of the pond was sampled with the typical standardized suite of gear used for small standing water systems on two occasions (three fyke nets, 15 minnow traps, one trammel net) and with a more intensive suite of gear (five fyke nets, 15 minnow traps, two trammel net) on two more occasions. Altogether, over 3 days, this represented 82 units of effort or pieces of gear at 12 sites that sampled 1 resource with one habitat types (Figure 7).

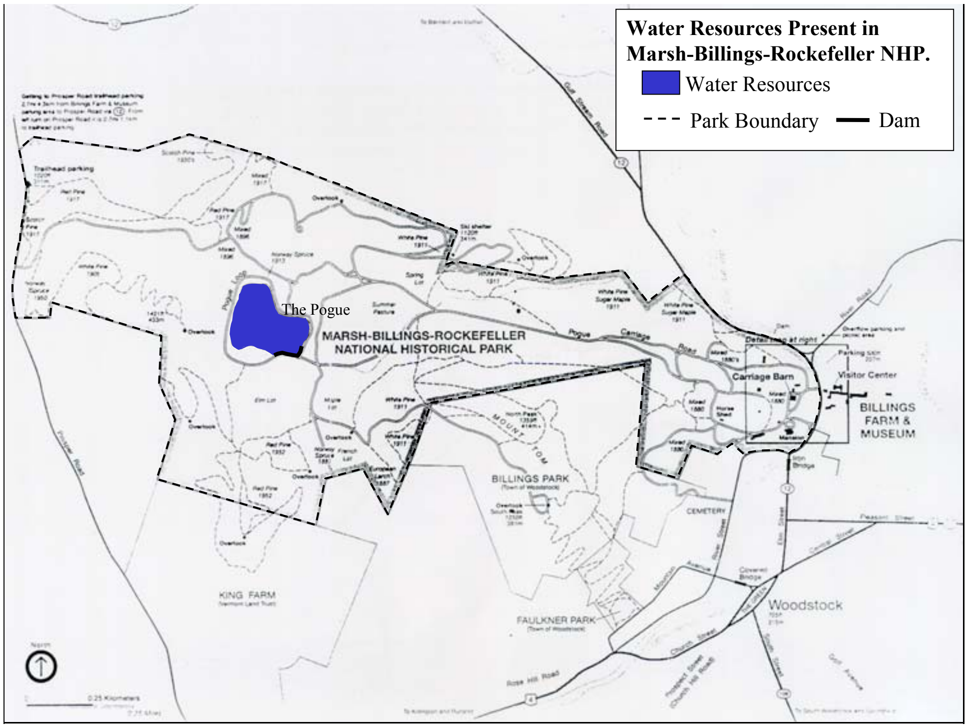

Figure 4. Water resources present in Marsh-Billings-Rockefeller NHP.

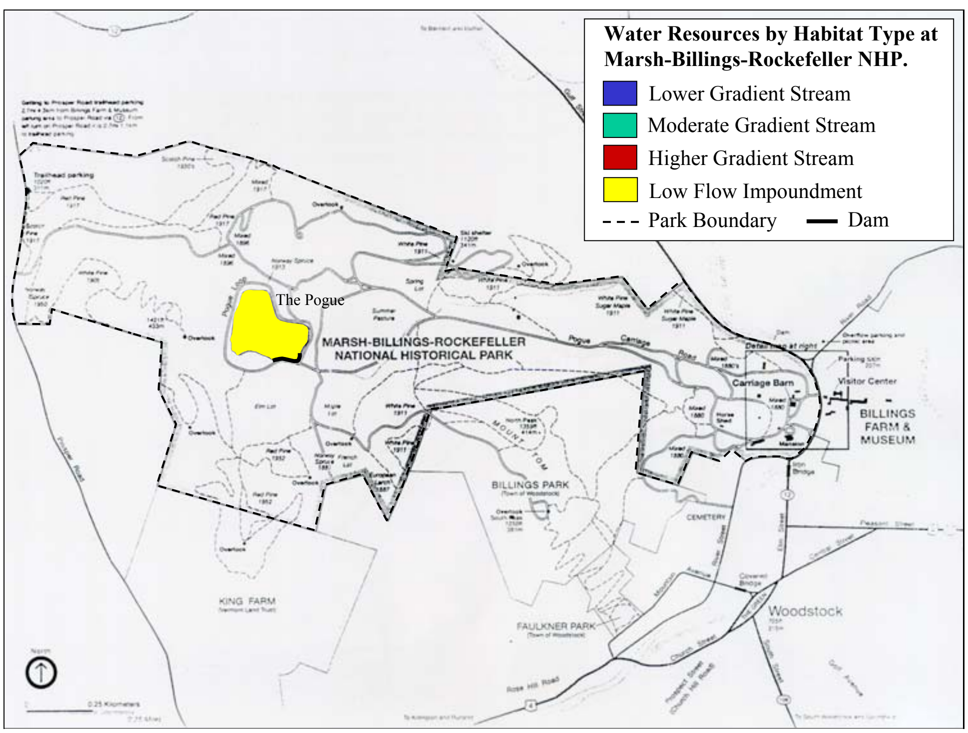

Figure 5. Water resources by habitat type at Marsh-Billings-Rockefeller NHP.

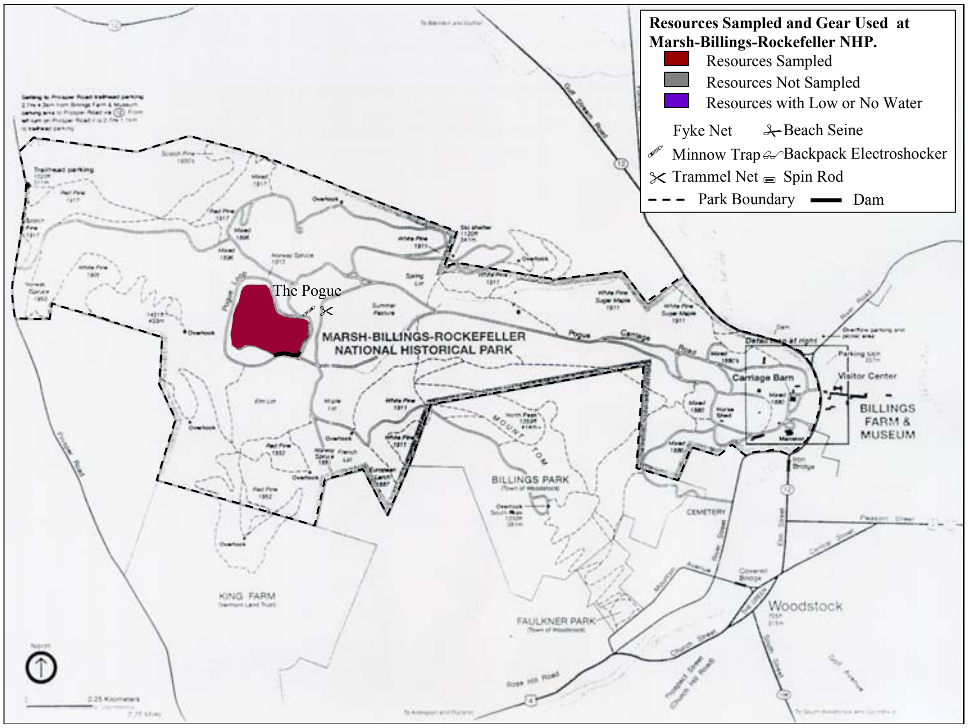

Figure 6. Resources sampled and gear used at Marsh-Billings-Rockefeller NHP.

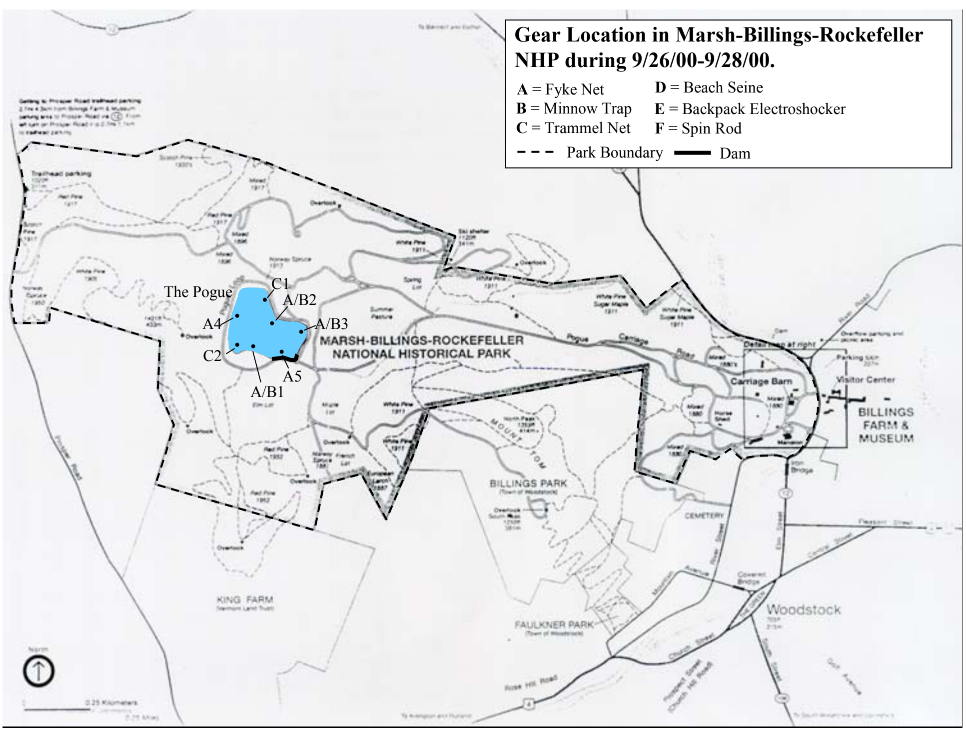

Figure 7. Gear locations at Marsh-Billings-Rockefeller NHP.

The Fish Community

The Pogue contained two species (largemouth bass and yellow perch) belonging to two families: Centrarchidae: largemouth bass and Percidae: yellow perch (Figure 8). Of these, yellow perch are native. Largemouth bass are not native but have been residents of many northeastern systems for over a hundred years, are naturally reproducing, and typically not considered threats to native biodiversity. In fact, largemouth bass are sought out by many recreational anglers. Both the yellow perch and the largemouth bass generally inhabit the inshore, littoral zone and use shelter and vegetation both for foraging and to avoid predators. Largemouth bass are nest builders, that is, in the spring, the males build nests in the shallow inshore area, attract females, then guard the eggs until the young bass hatch. Hence, any change in water level in the spring can impact reproduction. Yellow perch change their diet with size. Young perch, like most fish, are planktivorous. Throughout most of their lives, they add benthic invertebrates to their diet. At large sizes, yellow perch can become fish-eating or piscivorous predators. Largemouth bass throughout most of their lives are piscivorous predators. Both yellow perch and largemouth bass are considered desirable species and many small ponds contain this combination of prey fish (yellow perch) and predators (largemouth bass). Neither of these species are threatened, endangered, or of special concern.

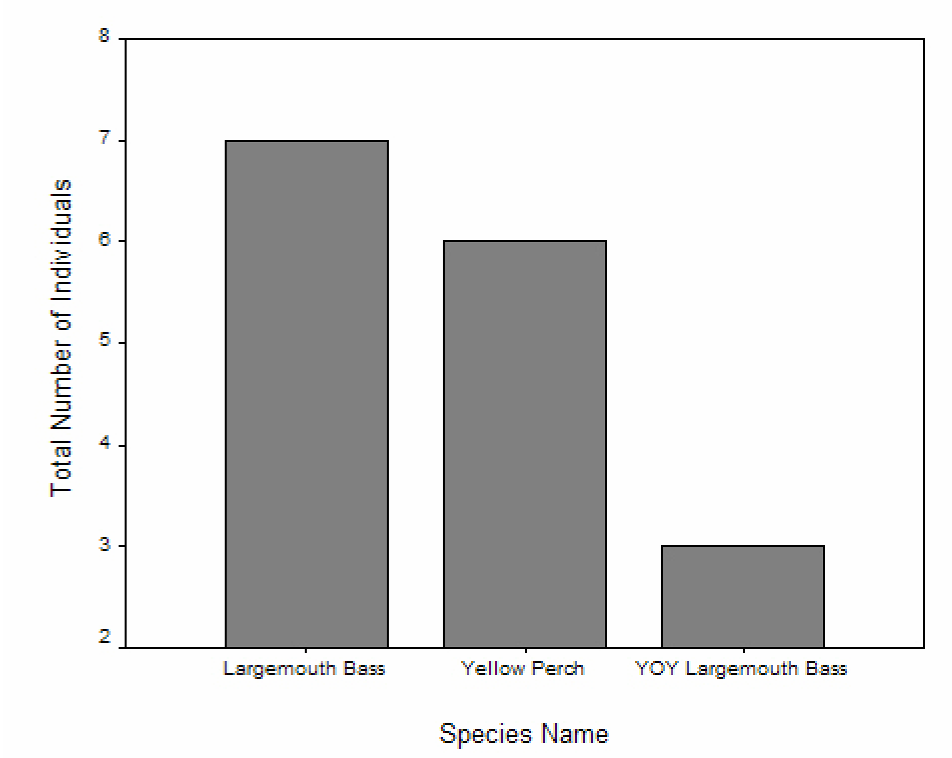

Figure 8. Species and total number of individuals detected at Marsh-Billings-Rockefeller NHP, 2000.

Summary

The Pogue, pre winter kill, 2001, seemed like a healthy system with natural reproduction although numbers were relatively low (Table 7). Sizes of these fish covered a range of values. Although there are only two species, small systems with limited emigration often have low diversity. Because previous residents of this park were avid fisherman and stocked the pond for fishing, maintaining largemouth bass and their prey should be a priority for the park.

Table 7. Marsh-Billings-Rockefeller NHP sample locations, habitat types, and number of species identified.

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
The Pogue	Low flow impoundment	Largemouth Bass	7	1.40	0.55
		No Fish	0	0.00	0.00
		Yellow Perch	6	2.00	1.00
		YOY Largemouth Bass	3	1.00	0.00
	Total	Largemouth Bass	7	1.40	0.55
		No Fish	0	0.00	0.00
		Yellow Perch	6	2.00	1.00
		YOY Largemouth Bass	3	1.00	0.00

Previous records

Previous sampling records are useful to determine the potential species pool. However, less common and highly variable (but not necessarily rare/threatened/endangered) species may not be caught in every inventory effort because of variability and chance not because these species are decreasing in abundance. These less common and highly variable species often comprise a substantial portion of any animal community (i.e., this is the basis for the lognormal distribution of species often used in theoretical models). The catch of these less common and highly variable species is exacerbated by different sampling methodologies and levels of effort. Hence, it is difficult to draw conclusions about changes in freshwater fish communities from occasional surveys. This is why we recommend repeating the same type of sampling at the same sites at the same effort levels for several years to get a baseline species list. Once this is established, changes through time can be interpreted with increased confidence.

We compiled previous information on fish. No formal surveys have documented fish communities at MABI in the so no useful evaluation of change in fish communities is possible. The list of potential species is based on informal communications. In our opinion, little is to be gained by analyzing this sort of anecdotal information.

Anthropogenic Effects

Land Use

A major source of anthropogenic effects are those associated with changing land use. As the amount of forest is decreased and as development and/or agriculture increase, a number of effects can occur that can have adverse effects on freshwater fish. First, as the amount of vegetation decreases, the hydrograph changes. Often more water flows over land and less percolates into the ground water. As a result, extreme flow conditions increase and both floods and droughts are exacerbated. This change in water quantity and especially the variation in water quality can have adverse effects on many fish. Second, roads and other paved areas will increase runoff. Third, a change in riparian corridor can have adverse effects on stream water quality. The resulting increased runoff from development, roads, and an altered riparian area can increase the amount of sediment, nutrients, salt, and car oil in the lakes and streams. A decrease in water quality can, of course, have an adverse effect on freshwater fish by affecting basic physiology/metabolism, increasing disease, and affecting spawning and egg development. Changes in land use should be monitored for the watershed in which the park resides. If land use changes, water quality, sediment, and incidence of disease should be monitored. Seasonal flow regimes should also be documented.

Contaminants

Contaminants from industry can have an adverse effect on fish physiology. In areas where contaminants are know to exist, water quality, contaminant loads, and fish communities should be carefully watched.

Animals that affect vegetation and water flow

Beaver and deer are increasing in many suburban/urban areas. Beaver, by damming streams, can slow/stop flow and change the community from a flowing system to a standing water one. Deer can overgraze riparian areas and cause increased sedimentation and runoff. If either of these animals is common in the area of the park, water quality, flow regime, and fish communities should be carefully monitored.

Dams

Dams are an integral part of many northeastern systems. If drawdown is planned to repair dams, care should be taken not to adversely affect those fish that live in the impoundment margin. This can be done by simply watching how much inshore substrate is dewatered by the drawdown. If possible, avoid drawdown in spring when sunfish are building nests in the shallows.

Stocking, Visitation, and Invading Species

Adding new species to any system can be a danger to the existing community. Often with increased human activity, species are transplanted between water bodies. Visitors should be warned about the dangers of this. Stocking should be relegated to tested programs. Monitoring fish species composition should alert the park to new species.

Vegetation

In many systems, aquatic vegetation is critical to fish community structure. Changes in vegetation could change the fish communities drastically. Changes in water quality, nutrients, and other factors that affect aquatic vegetation should be monitored as should the vegetation itself and the fish communities that use it.

All of these effects could be important in any of the NPS sites in the northeast. All parks are potentially affected by changing land use, changes in water quantity/quality, nutrient enrichment from urbanization and farming, and runoff from roads.

Future Work

Because this was one of the first systems sampled, we expended excessive effort to make sure the gear sampled effectively and that the sampling regime was rigorous. Although predators are harder to sample as are rare species, one set of gear (fyke net, minnow traps, and trammel nets) would probably suffice as an index of species present. Our recommendation is that the northeast parks band together and institute a sampling plan where they work together as a team to sample each park for fish every other year. Future efforts should be expended fine tuning the standardized effort of gear used and the target reference system for the park.

Results for Minute Man National Historical Park

Freshwater Habitat

Minute Man National Historical Park (MIMA) has three units: Main Unit, North Bridge Unit, and Wayside Unit. Our team sampled 8 of 10 possible aquatic resources within these three units (Figures 9-11). The aquatic resources that we sampled within Minute Man National Historical Park included small pond/low flow impoundments (Main Unit: Un-named pond, Folly Pond, Palumbo's Farm Pond), lower gradient streams (Main Unit: Mill Brook, Elm Brook; North Bridge Unit: Mill Brook; Wayside Unit; Mill Brook), moderate gradient streams (North Bridge Unit: Un-named Brook), and higher gradient streams (Main Unit: Elm Brook). Low flow impoundments are bodies of water with a man-made dam that form a small pond or lake with minimal inflow and outflow. Ponds are similar small standing water systems that have no dam. Lower gradient streams are slower moving, soft-bottomed systems with many large pools. Moderate gradient streams are defined as faster moving, gravel and cobble bottomed systems, with riffles and runs. Higher gradient streams are extremely fast moving, rock to boulder bottomed systems with runs, falls, and plunge pools. Defining habitat type is important for both the selection of effective sampling gear and the identification of potential fish communities (Figures 12-14).

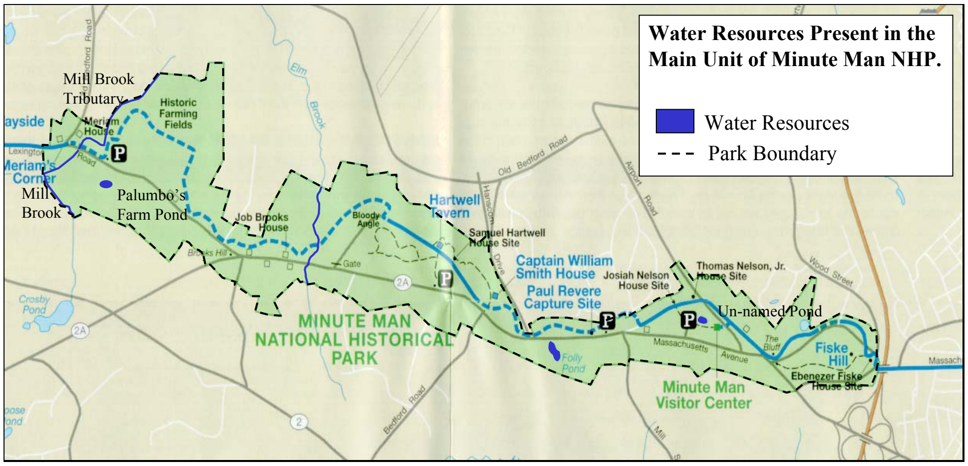

Figure 9. Water resources present in the Main Unit of Minute Man NHP.

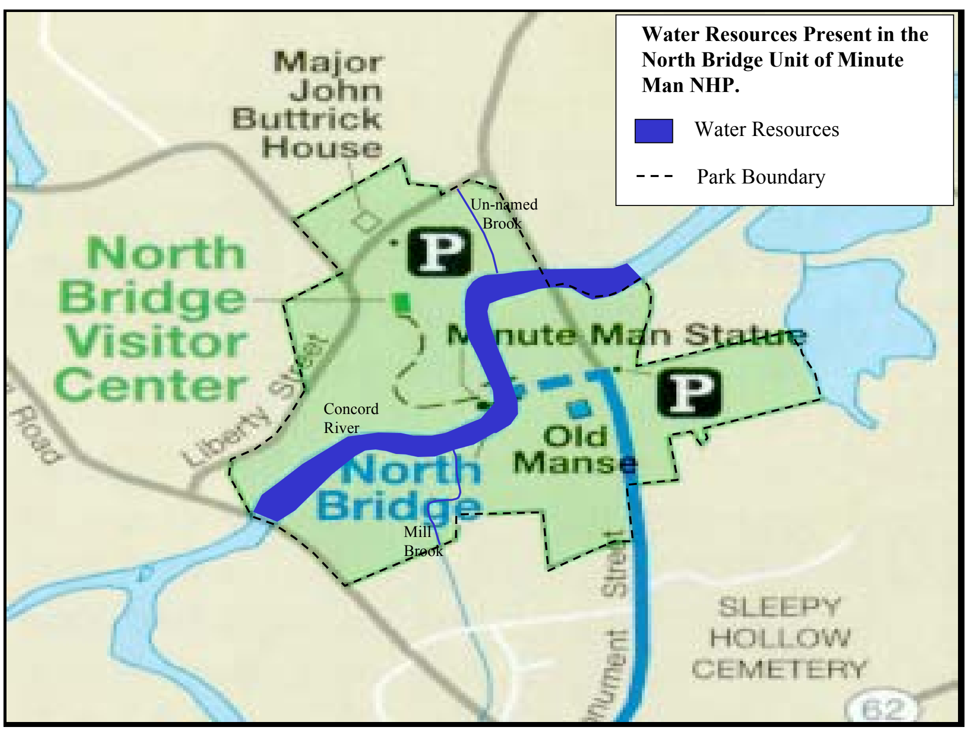

Figure 10. Water resources present in the North Bridge Unit of Minute Man NHP.

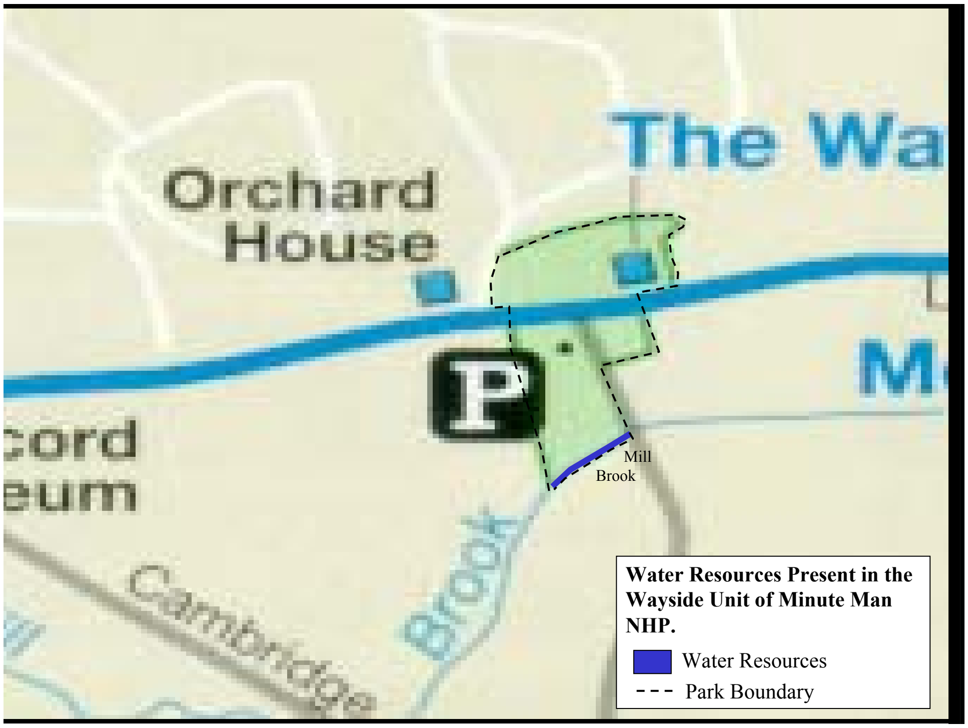

Figure 11. Water resources present in the Wayside Unit of Minute Man NHP.

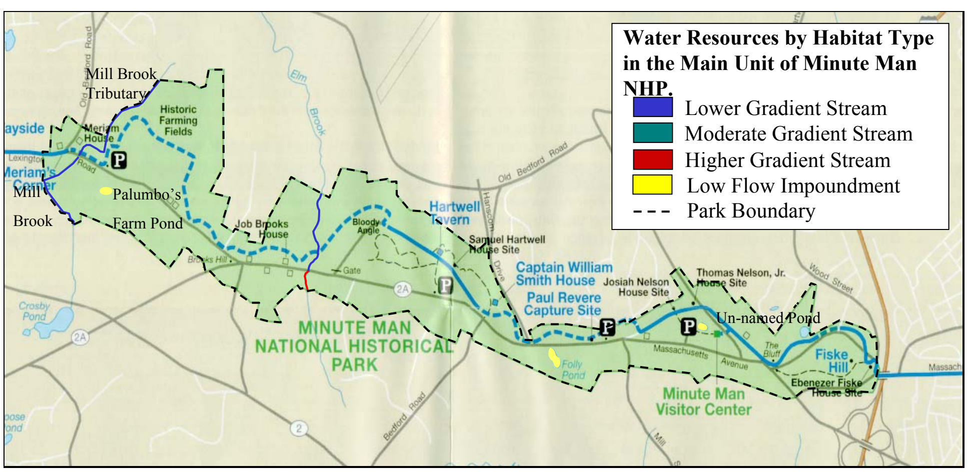

Figure 12. Water resources by habitat type in the Main Unit of Minute Man NHP.

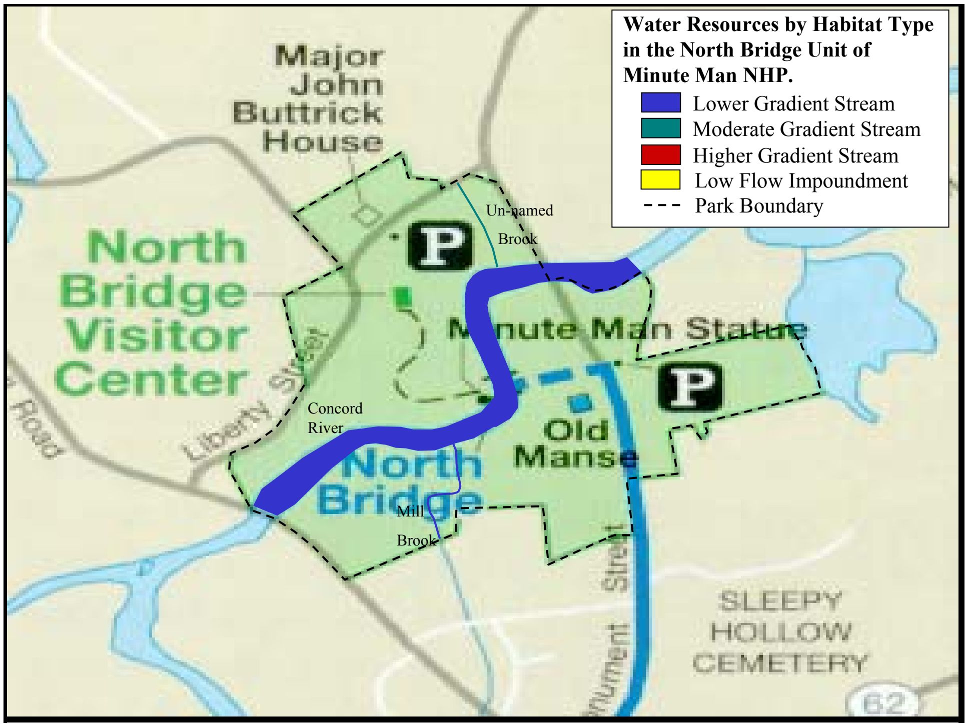

Figure 13. Water resources by habitat type in the North Bridge Unit of Minute Man NHP.

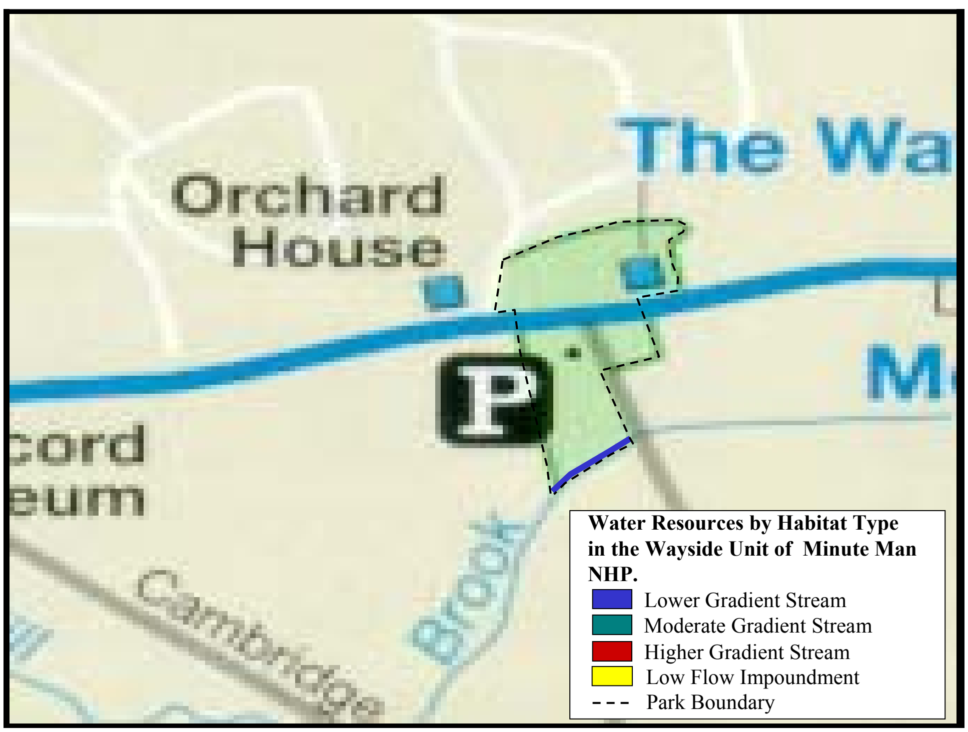

Figure 14. Water resources by habitat type in the Wayside Unit of Minute Man NHP.

Sampling Intensity

Habitats at Minute Man National Historical Park were sampled for fish in October, 2000 (Figures 15-17). We tried to sample habitat types with a standard, repetitive effort. However, sometimes the standard effort had to be modified because of system size, bottom type, or other constraints. In general, we sampled low, medium, and high gradient streams with a stream electrofisher repeated for 25 m^2 transects until our catch curve flattened out, i.e., no or few new species caught or 10% of the habitat was sampled. In general, ponds and low flow impoundments were sampled with repetitions of 15 minnow traps and three fyke nets. When the system was large enough, a trammel net was used. In the atypical circumstances in which bottoms were hard and smooth, a beach seine was also included. At Minute Man, neither a trammel net nor a beach seine could be used.

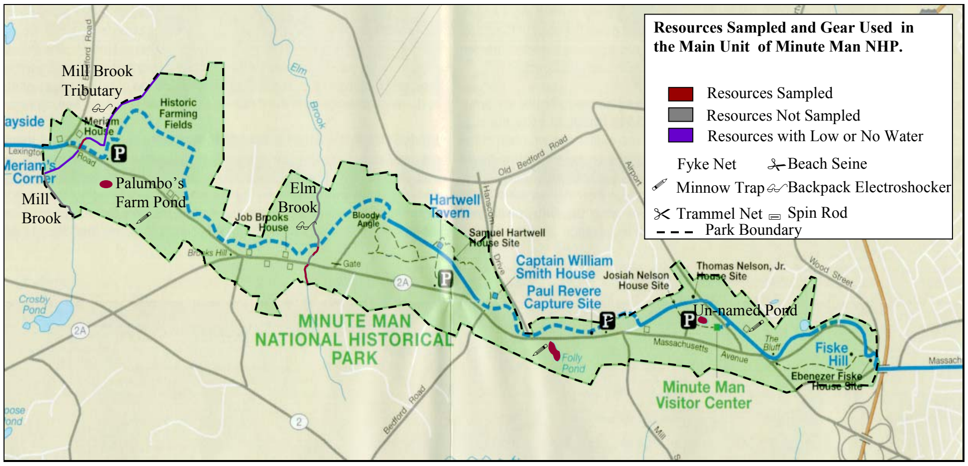

Figure 15. Resources sampled and gear used in the Main Unit of Minute Man NHP.

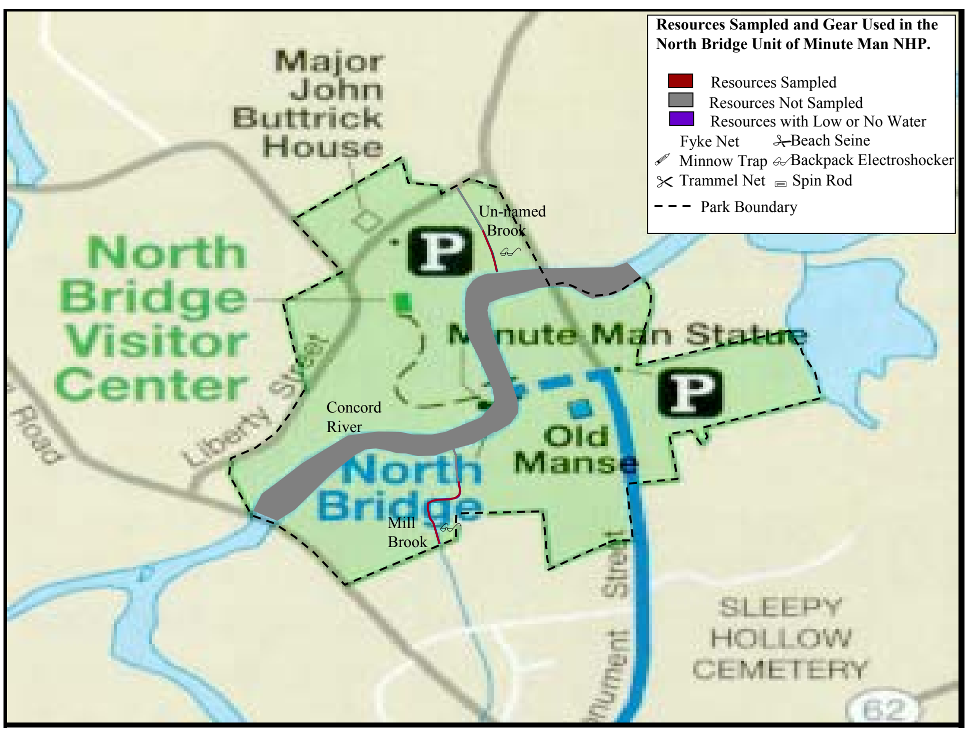

Figure 16. Resources sampled and gear used in the North Bridge Unit of Minute Man NHP.

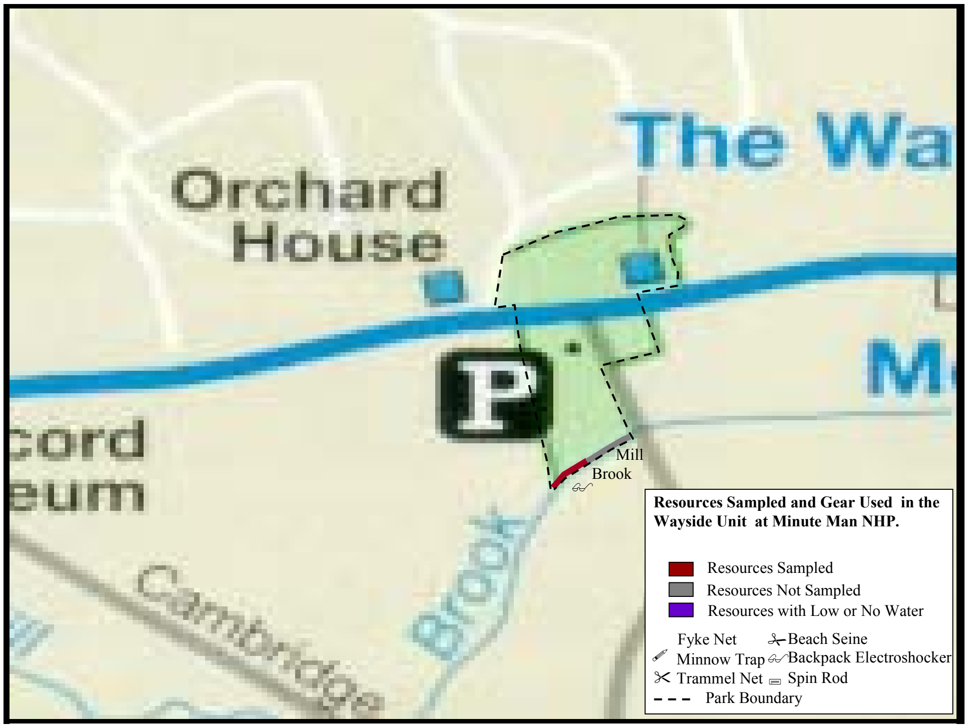

Figure 17. Resources sampled and gear used in the Wayside Unit of Minute Man NHP.

During the four days of sampling in October 2000, at MIMA, 8 of 10 possible resources were sampled at 15 sites resulting in 99 total units of effort. Of these, 12 units of effort were expended sampling Elm Brook, Mill Brook, Un-named Brook (North Bridge Unit) with a stream electrofisher. This sampling covered 8-10% of the total flowing water habitat at this park. During this same sampling period, the impoundment and small pond habitats (Main Unit: Palumbos Farm Pond, Un-named Pond, Folly Pond) were sampled at 9 sites representing 87 units of effort (4 repetitions of 15 minnow traps, 3 fyke nets=8 sites=72 units of effort) and one repetition of 15 minnow traps only (1 site=15 units of gear) (Figures 18-20). The ponds were too small for trammel nets and too uneven for beach seines. Palumbos Pond and Un-named Pond-Main Unit were sampled with two repetitions each of the standardized unit of gear (3 fyke nets + 15 minute traps). Because of size and bottom type, a more limited suite of gear (15 minnow traps) was used to sample Folly Pond. Thus in 4 days, we sampled 8 of 10 resources at 15 sites representing 4 habitat types with 99 units of effort/pieces of gear.

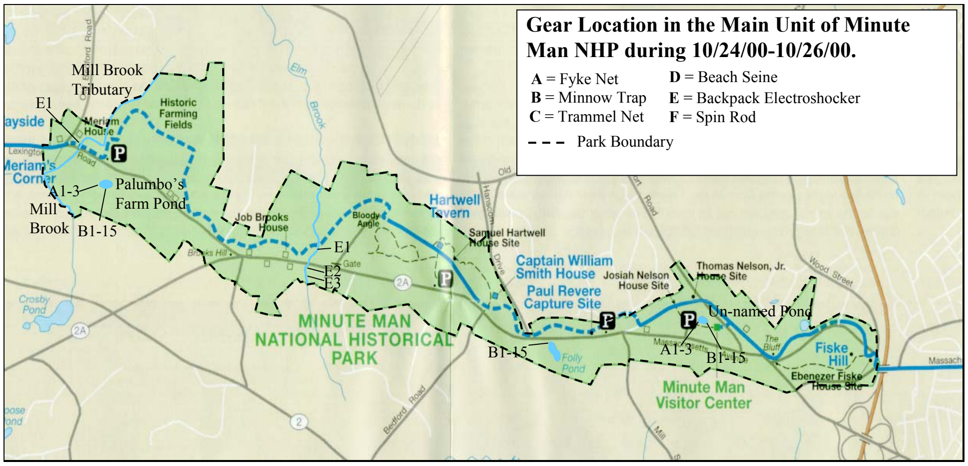

Figure 18. Gear Location in the Main Unit of Minute Man NHP.

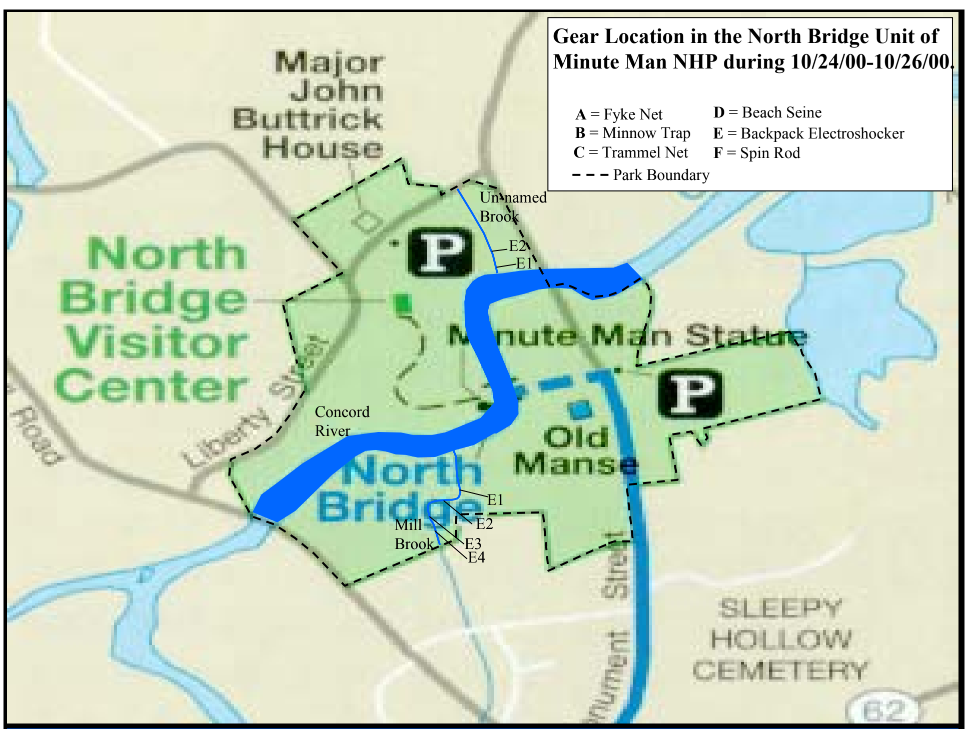

Figure 19. Gear location in the North Bridge Unit of Minute Man NHP.

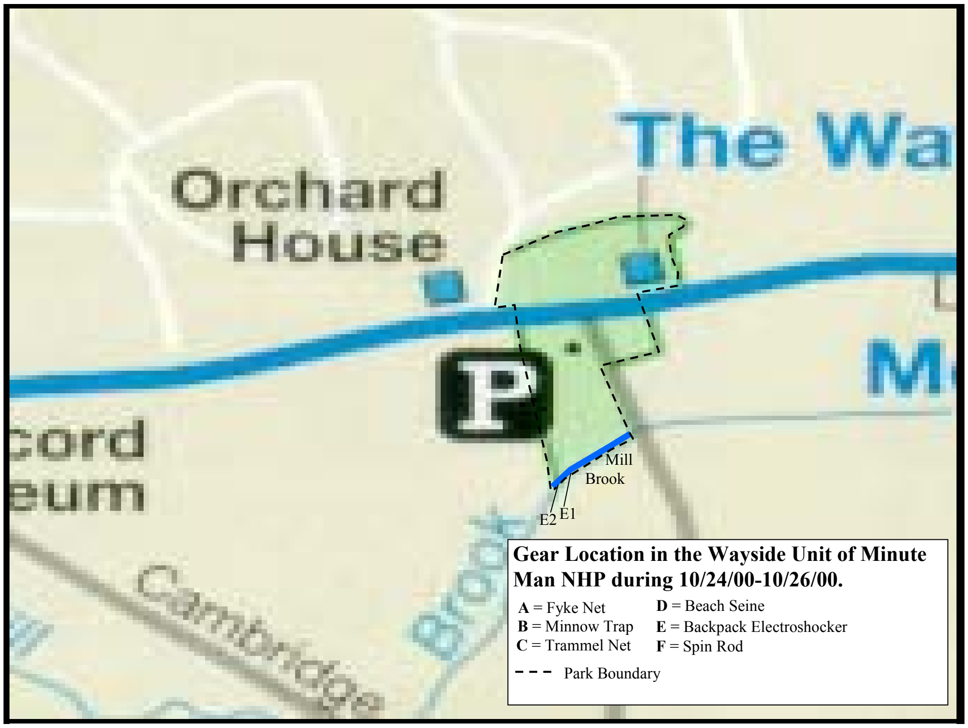

Figure 20. Gear location in the Wayside Unit of Minute Man NHP.

The Fish Community

Overall, Minute Man National Historical Park contained 10 freshwater fish species: American eel, bluegill sunfish, brook trout, brown bullhead, golden shiner, green sunfish, largemouth bass, pumpkinseed sunfish, redfin pickerel, and yellow perch (Figure 21). These species belong to seven families: Anguillidae (American eel), Centrarchidae (bluegill sunfish, green sunfish, largemouth bass, pumpkinseed sunfish), Salmonidae (brook trout), Ictaluridae (brown bullhead), Cyprinidae (golden shiner), Esocidae (redfin pickerel), and Percidae (yellow perch) (Table 8). Of these, all but bluegill sunfish, green sunfish, and largemouth bass are natives. These three non-native centrarchids are widely distributed in the northeast and often are stable, naturally-reproducing members of freshwater communities. As a rule, they are not considered a threat to native biodiversity.

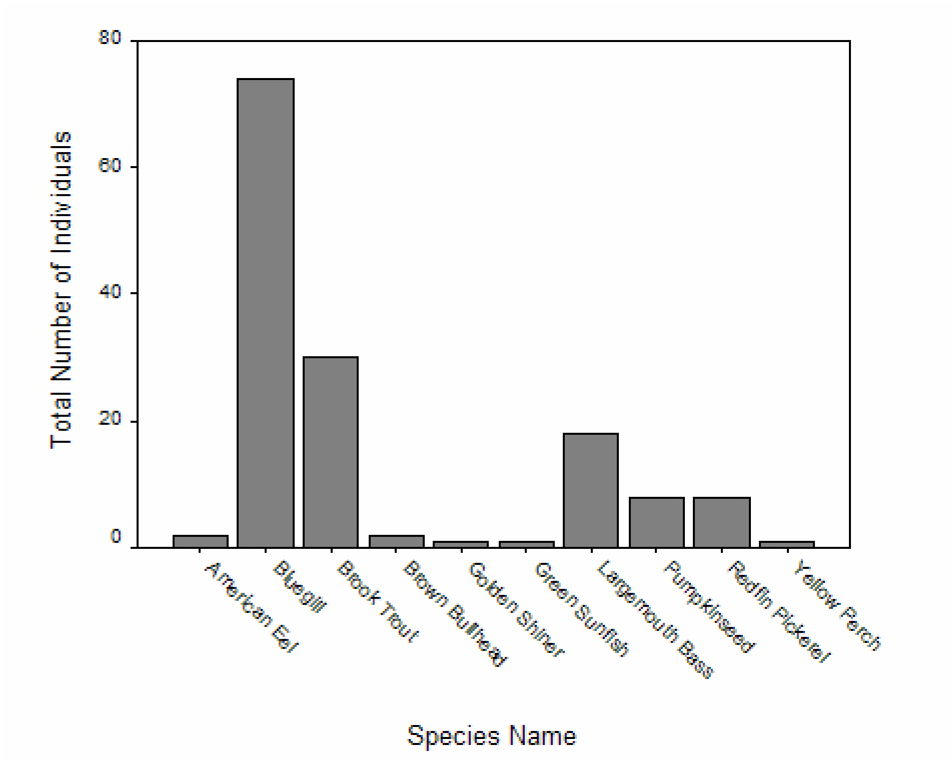

Figure 21. Species and total number of individuals detected at Minute Man NHP, 2000.

Table 8. Minute Man NHP sample locations, habitat types, and number of species, and individuals detected.

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Dev
Elm Brook	Higher gradient stream	American Eel	2	1.00	0.00
		Brook Trout	29	14.50	3.54
		Redfin Pickerel	1	1.00	.
	Lower gradient stream	Brook Trout	1	1.00	.
		Redfin Pickerel	3	3.00	.
Folly Pond	Low flow impoundment	No Fish	0	0.00	.
Mill Brook	Lower gradient stream	Golden Shiner	1	1.00	.
		Green Sunfish	1	1.00	.
		Pumpkinseed	2	2.00	.
		Redfin Pickerel	3	1.00	0.00
		Yellow Perch	1	1.00	.
Mill Brook Tributary	Lower gradient stream	No Fish	0	0.00	.
Palumbo's Farm Pond	Low flow impoundment	Brown Bullhead	2	1.00	0.00
		Pumpkinseed	2	2.00	.
		Redfin Pickerel	1	1.00	.
Un-named Brook	Moderate gradient stream	No Fish	0	0.00	0.00
Un-named Pond	Low flow impoundment	Bluegill	74	9.25	8.07
		Largemouth Bass	18	3.00	2.10
		Pumpkinseed	4	1.00	0.00
Total	Higher gradient stream	American Eel	2	1.00	0.00
		Brook Trout	29	14.50	3.54
		Redfin Pickerel	1	1.00	.
	Low flow impoundment	Bluegill	74	9.25	8.07
		Brown Bullhead	2	1.00	0.00
		Largemouth Bass	18	3.00	2.10
		Pumpkinseed	6	1.20	0.45
		Redfin Pickerel	1	1.00	.
	Lower gradient stream	Brook Trout	1	1.00	.
		Golden Shiner	1	1.00	.
		Green Sunfish	1	1.00	.

Table 8. Minute Man NHP sample locations, habitat types, and species found (continued).

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Dev
		Pumpkinseed	2	2.00	.
		Redfin Pickerel	6	1.50	1.00
		Yellow Perch	1	1.00	.
	Moderate gradient stream	No Fish	0	0.00	0.00

Summary

Many of the fish at Minute Man National Historical Park are characteristic of those found in slow moving or standing waters, and, in fact, were found in either low gradient streams (yellow perch, golden shiner, green sunfish), low flow impoundments (bluegill sunfish, brown bullhead, largemouth bass) or both low gradient streams and low flow impoundment (pumpkinseed sunfish) (Table 8). Except for piscivorous predators, i.e., largemouth bass, large yellow perch, large green sunfish, and the omnivorous brown bullhead, all of these fish feed primarily on invertebrates. Some, like bluegill specialize on pelagic zooplankton whereas others, like pumpkinseed, prefer benthic invertebrates. Brook trout, a common, drift-feeding, resident of clean, moderate velocity waters, were found in low gradient streams and was especially abundant in high gradient streams. American eel were found in only the high gradient systems. Redfin pickerel, a top predator, have the widest distribution occurring in three habitat types: low flow impoundments, low gradient, and high gradient streams. None of these species are threatened, endangered, or of special concern. However, brook trout, the only non-anadromous salmonid native to the northeast, are prized by many recreational anglers.

These species cover a range of ecological roles. Golden shiners are obligate plantivores. Largemouth bass and redfin pickerel specialize on fish prey. A number of other species including bluegill sunfish, small and medium brook trout, small green sunfish, pumpkinseed sunfish, and yellow perch, are diet generalists and feed on a range of invertebrate taxa and sizes. Small brook trout can feed on invertebrate drift whereas large trout may consume small fish as well. The omnivorous American eel and brown bullhead consume a wide range of diet items. Across all samples, bluegill, brook trout and largemouth bass were most numerous. Golden shiner, green sunfish, and yellow perch were rare in our samples.

Previous records

Previous sampling records are useful to determine the potential species pool. However, less common and highly variable (but not necessarily rare/threatened/endangered) species may not be caught in every inventory effort because of variability and chance not because these species are decreasing in abundance. These less common and highly variable species often comprise a substantial portion of any animal community (i.e., this is the basis for the lognormal distribution of species often used in theoretical models). The catch of these less common and highly variable species is exacerbated by different sampling methodologies and levels of effort. Hence, it is difficult to draw conclusions about changes in freshwater fish communities from occasional surveys. This is why we recommend repeating the same type of sampling at the same sites at the same effort levels for several years to get a baseline species list. Once this is established, changes through time can be interpreted with increased confidence.

We compiled previous information on fish sampling. No formal surveys have documented fish communities at MIMA in the past so no useful evaluation of change in fish communities is possible. The list of potential species is based on a general regional listing and is much broader than what is realistically expected.

Anthropogenic Effects

Land Use

A major source of anthropogenic effects are those associated with changing land use. As the amount of forest is decreased and as development and/or agriculture increase, a number of effects can occur that can have adverse effects on freshwater fish. First, as the amount of vegetation decreases, the hydrograph changes. Often more water flows over land and less percolates into the ground water. As a result, extreme flow conditions increase and both floods and droughts are exacerbated. This change in water quantity and especially the variation in water quality can have adverse effects on many fish. Second, roads and other paved areas will increase runoff. Third, a change in riparian corridor can have adverse effects on stream water quality. The resulting increased runoff from development, roads, and an altered riparian area can increase the amount of sediment, nutrients, salt, and car oil in the lakes and streams. A decrease in water quality can, of course, have an adverse effect on freshwater fish by affecting basic physiology/metabolism, increasing disease, and affecting spawning and egg development. Changes in land use should be monitored for the watershed in which the park resides. If land use changes, water quality, sediment, and incidence of disease should be monitored. Seasonal flow regimes should also be documented.

Contaminants

Contaminants from industry can have an adverse effect on fish physiology. In areas where contaminants are know to exist, water quality, contaminant loads, and fish communities should be carefully watched.

Animals that affect vegetation and water flow

Beaver and deer are increasing in many suburban/urban areas. Beaver, by damming streams, can slow/stop flow and change the community from a flowing system to a standing water one. Deer can overgraze riparian areas and cause increased sedimentation and runoff. If either of these animals is common in the area of the park, water quality, flow regime, and fish communities should be carefully monitored.

Dams

Dams are an integral part of many northeastern systems. If drawdown is planned to repair dams, care should be taken not to adversely affect those fish that live in the impoundment margin. This can be done by simply watching how much inshore substrate is dewatered by the drawdown. If possible, avoid drawdown in spring when sunfish are building nests in the shallows.

Stocking, Visitation, and Invading Species

Adding new species to any system can affect existing species. Often with increased human activity, species are transplanted between water bodies. Visitors should be warned about the dangers of this. Stocking should be relegated to tested programs. Monitoring fish species composition should alert the park to new species.

Vegetation

In many systems, aquatic vegetation is critical to fish community structure. Changes in vegetation could change the fish communities drastically. Changes in water quality, nutrients, and other factors that affect aquatic vegetation should be monitored as should the vegetation itself and the fish communities that use it.

All of these effects could be important in any of the NPS sites in the northeast. All parks are potentially affected by changing land use, changes in water quantity/quality, nutrient enrichment from urbanization and farming, and runoff from roads. .

Future Work

A good effort was expended sampling Minute Man. Although, it is unlikely that any limited sampling will capture all species, especially, rare ones, we think that we sampled a representative portion of the species. Electrofishing at flowing water index sites and a regular effort of fyke nets and minnow traps at low flow impoundments should provide a good index of changes in species in these systems. Our recommendation is that the northeast parks band together and institute a sampling plan where they work together as a team to sample each park for fish every other year. Future efforts should be expended fine tuning the standardized effort of gear used and the target reference system for the park.

Results for Morristown National Historical Park

Freshwater Habitats

Morristown National Historical Park (MORR) contains 7 aquatic resources with freshwater fish: Indian Grave Brook, Passaic River, Main Branch Primrose Brook, East Primrose Brook, West Primrose Brook, Jersey Brook, and Cat Swamp Pond (Figure 22). All seven of these resources were sampled. These resources include four habitat types: low flow impoundments/small ponds, lower gradient streams, moderate gradient streams, and higher gradient streams (Figure 23). Low flow impoundments are defined as bodies of water with a man-made dam that form a small pond or lake with minimal inflow and outflow. Small ponds are similar systems without a dam. Lower gradient streams are defined as slower moving, soft-bottomed systems with many large pools. Moderate gradient streams have faster moving, gravel and cobble bottomed systems with riffles and runs. Higher gradient streams are extremely fast moving systems with runs, falls, and plunge pools flowing over rock to boulder substrates. Cat Swamp Pond is a low flow impoundment. Indian Grave Brook and the Passaic River contain both moderate and higher gradient stream habitat. Primrose Brook and Jersey Brook contain only moderate gradient stream habitat. East and West Primrose Brook contain both low and moderate gradient stream habitat. Defining habitat type is important for both the selection of effective sampling gear and to identify potential fish communities.

Figure 22. Water resources present in Morristown NHP.

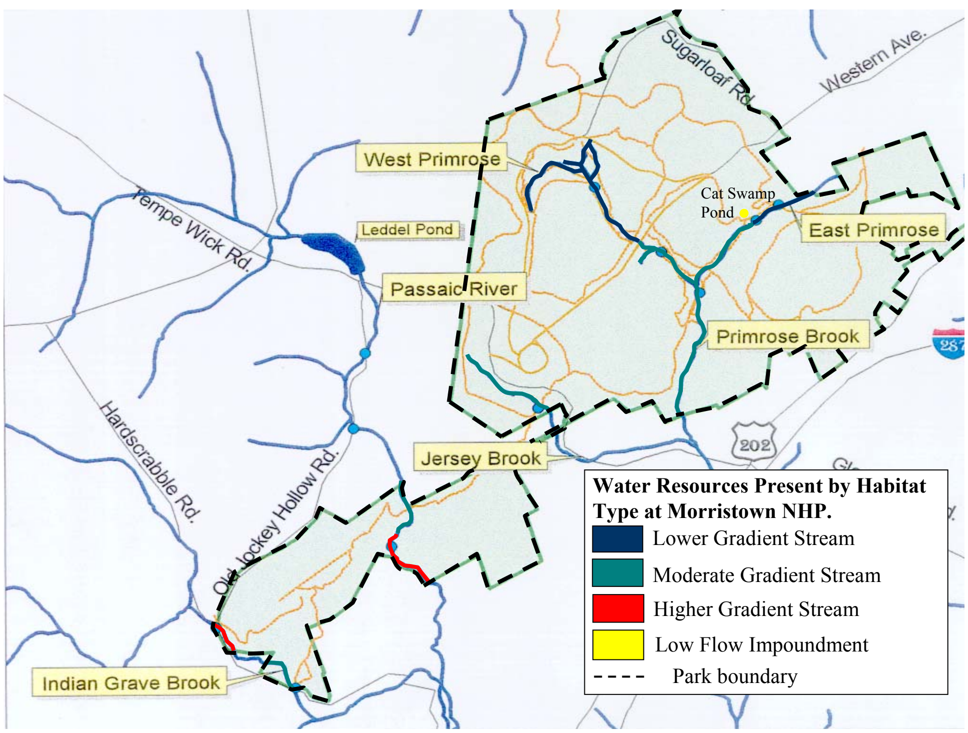

Figure 23. Water resources present by habitat type at Morristown NHP.

Sampling Intensity

Habitats at Morristown were surveyed in October, 1999 and sampled for fish in October, 2000. We tried to sample habitat types with a standard, repetitive effort. However, sometimes the standard effort had to be modified because of system size, bottom type, or other constraints. In general, we sampled low, medium, and high gradient streams with a stream electrofisher repeated in 25 m transects until our catch curve flattened out, i.e., no or few new species caught or 10% of the habitat was sampled. In general, ponds and low flow impoundments were sampled with repetitions of 15 minnow traps and 3-5 fyke nets (Figure 24). When the system was large enough, a trammel net was used. In the atypical circumstances in which bottoms were hard and smooth, a beach seine was also included. At Morristown, neither a trammel net nor a beach seine was used.

During the four days of sampling, we sampled 10 sites within the 7 resources using 59 units of effort (pieces of gear). Of these, 39 units of effort/gear were expended sampling 6 resources at 8 stream sites with a backpack electrofisher (Figure 25). This effort sampled 11-28% of the total flowing water habitat at Morristown. The pond habitat was sampled with the traditional standing water gear of 5 fyke nets and 15 minnow traps representing sampling at 2 sites with 20 units of effort/gear.

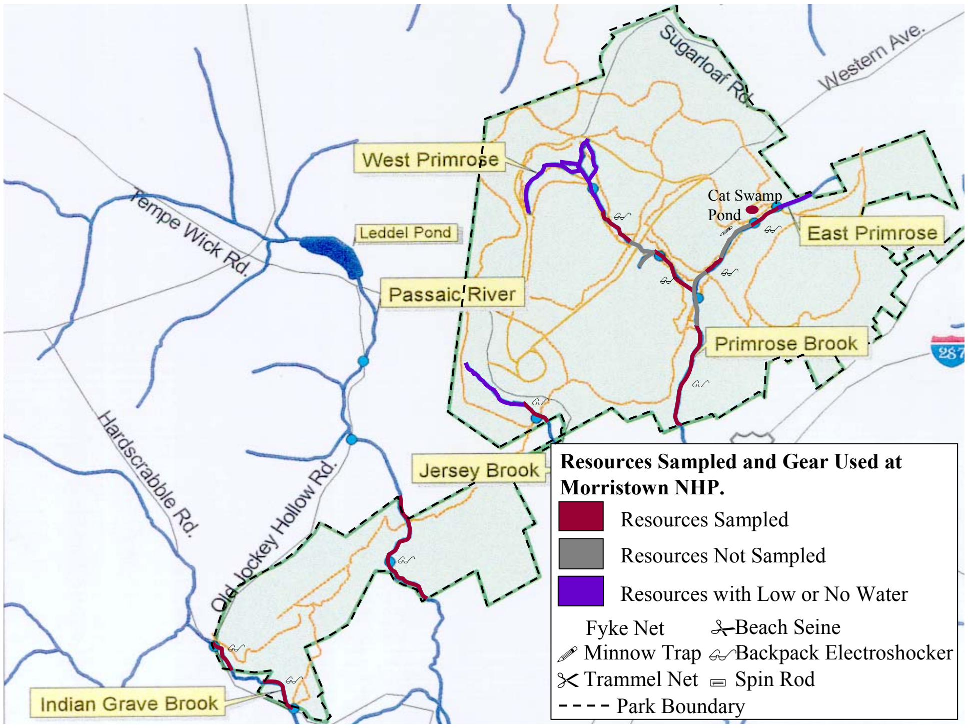

Figure 24. Resources sampled and gear used at Morristown NHP.

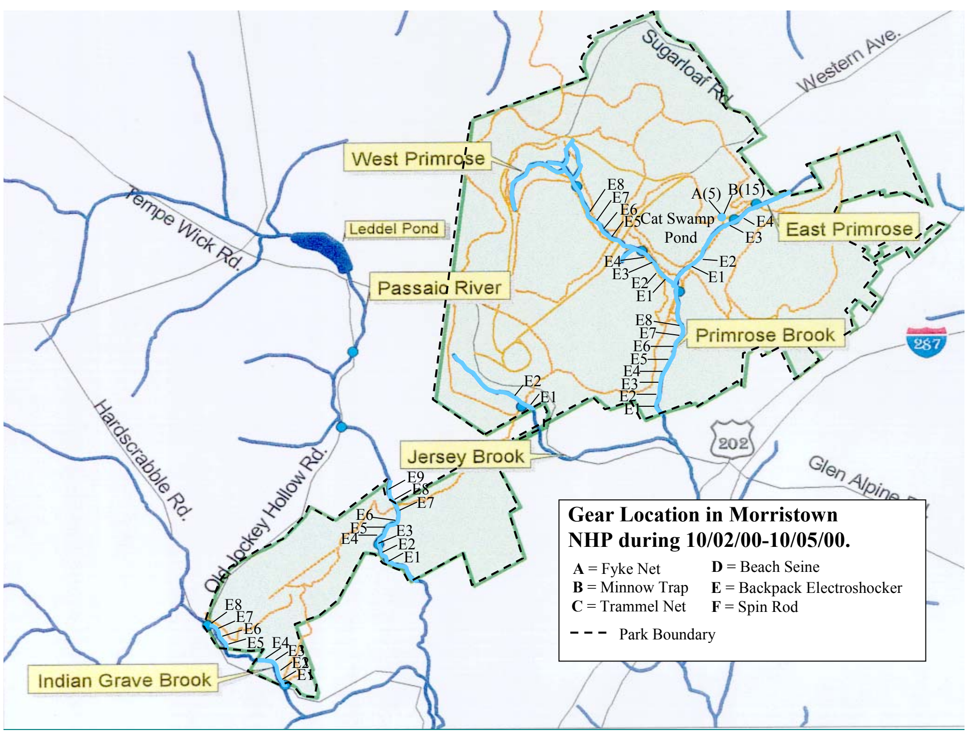

Figure 25. Gear location at Morristown NHP.

The Fish Community

Morristown contained eleven species: blacknose dace, bluegill sunfish, brook trout, brown trout, rainbow trout, creek chub, golden shiner, slimy sculpin, spottail shiner, tesselated darter, white sucker (Figure 26). These species represented six families: Cyprinidae: blacknose dace, creek chub, golden shiner, spottail shiner; Centrarchidae: bluegill sunfish; Salmonidae: brook, brown, rainbow trout; Cottidae: slimy sculpin; Percidae: tesselated darter; Catastomidae: white sucker. Of these, all but bluegill sunfish, brown trout, and rainbow trout are native. Bluegill sunfish although not native have been in many northeastern systems for over a hundred years, are naturally reproducing, and are not typically considered a threat to native biodiversity. Brown trout and rainbow trout are often stocked for fishing and valued by anglers.

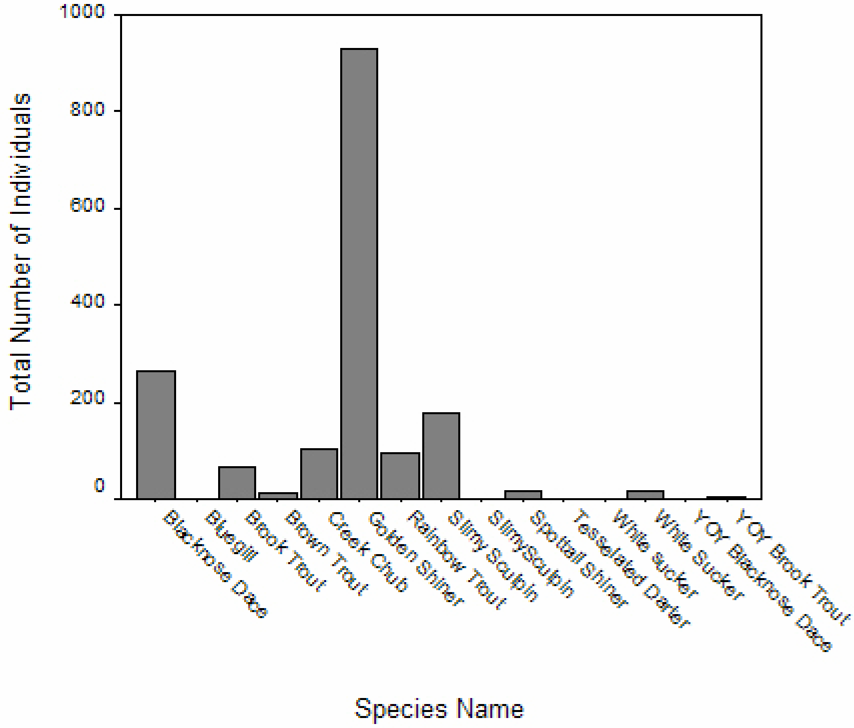

Figure 26. Species and total number of individuals detected at Morristown NHP, 2000.

All species but golden shiner were found in one of the stream habitats. Slimy sculpin and spottail shiner were found in low and moderate gradient streams. Brown trout, rainbow trout, creek chub, and white sucker were found in moderate and high gradient streams. Tessellated darter and bluegill were found only in the higher gradient streams. Blacknose dace and brook trout were found in all three stream habitats. The golden shiner was found only in the low flow impoundment/pond habitat. Across all habitats, blacknose dace, brook trout, creek chub, golden shiner, rainbow trout, slimy sculpin were abundant (Table 9). Only one tesselated darter was found (Table 9).

Table 9. Morristown NHP sampling locations, habitat types, and number of species identified.

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
Cat Swamp Pond	Low flow impoundment	Golden Shiner	930	116.25	162.79
East Primrose Brook	Lower gradient stream	Blacknose Dace	10	5.00	5.66
		Slimy Sculpin	11	5.50	2.12
		Spottail Shiner	1	1.00	.
	Moderate gradient stream	Blacknose Dace	2	2.00	.
		Brook Trout	7	3.50	2.12
		Slimy Sculpin	11	5.50	0.71
		YOY Blacknose Dace	1	1.00	.
Indian Grave Brook	Higher gradient stream	Blacknose Dace	77	19.25	1.26
		Bluegill	1	1.00	.
		Creek Chub	76	19.00	11.22
		Rainbow Trout	15	3.75	2.22
		White sucker	1	1.00	.
		White Sucker	5	5.00	.
	Moderate gradient stream	Blacknose Dace	60	15.00	5.83
		Brown Trout	3	3.00	.
		Creek Chub	9	2.25	0.50
		Rainbow Trout	19	4.75	2.75
		White Sucker	4	2.00	1.41
Jersey Brook	Moderate gradient stream	Blacknose Dace	3	1.50	0.71
		Slimy Sculpin	1	1.00	.
		Spottail Shiner	5	5.00	.
Passaic River	Higher gradient stream	Blacknose Dace	16	5.33	3.06
		Brook Trout	3	3.00	.
		Brown Trout	5	1.67	1.15
		Creek Chub	3	1.50	0.71
		Rainbow Trout	20	6.67	4.04
		Tesselated Darter	1	1.00	.
		White Sucker	3	1.50	0.71
	Moderate gradient stream	Blacknose Dace	58	9.67	5.16

Table 9. Morristown NHP sampling locations,habitat types, and number of species identified (continued).

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
		Brown Trout	6	1.50	1.00
		Creek Chub	14	4.67	2.52
		Rainbow Trout	39	7.80	4.55
		White Sucker	2	1.00	0.00
Primrose Brk (Main Branch)	Moderate gradient stream	Blacknose Dace	24	3.00	1.69
		Brook Trout	31	3.88	1.96
		Slimy Sculpin	110	13.75	8.58
		Spottail Shiner	10	1.67	1.21
		White Sucker	4	2.00	1.41
West Primrose Brook	Lower gradient stream	Blacknose Dace	12	3.00	1.83
		Brook Trout	9	3.00	1.00
		Slimy Sculpin	21	7.00	5.00
		SlimySculpin	2	2.00	.
	Moderate gradient stream	Blacknose Dace	4	1.33	0.58
		Brook Trout	15	3.75	2.99
		Slimy Sculpin	24	6.00	2.58
		YOY Brook Trout	3	1.00	0.00
Total	Higher gradient stream	Blacknose Dace	93	13.29	7.70
		Bluegill	1	1.00	.
		Brook Trout	3	3.00	.
		Brown Trout	5	1.67	1.15
		Creek Chub	79	13.17	12.54
		Rainbow Trout	35	5.00	3.21
		Tesselated Darter	1	1.00	.
		White sucker	1	1.00	.
		White Sucker	8	2.67	2.08
	Low flow impoundment	Golden Shiner	930	116.25	162.79
	Lower gradient stream	Blacknose Dace	22	3.67	3.08
		Brook Trout	9	3.00	1.00
		Slimy Sculpin	32	6.40	3.78

Table 9. Morristown NHP sampling locations, habitat types, and number of species identified (continued).

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
		SlimySculpin	2	2.00	.
		Spottail Shiner	1	1.00	.
	Moderate gradient stream	Blacknose Dace	151	6.29	6.09
		Brook Trout	53	3.79	2.12
		Brown Trout	9	1.80	1.10
		Creek Chub	23	3.29	1.98
		Rainbow Trout	58	6.44	3.97
		Slimy Sculpin	146	9.73	7.71
		Spottail Shiner	15	2.14	1.68
		White Sucker	10	1.67	1.03
		YOY Blacknose Dace	1	1.00	.
		YOY Brook Trout	3	1.00	0.00

Summary

Bluegill sunfish typically are found in slow moving or standing water and consume plankton. Their presence in higher gradient streams was a surprise. Blacknose dace, creek chub, slimy sculpin, spottail shiner, tesselated darter, and white sucker are typical stream fish. Their adaptations to living in flowing water include a flattered body, large pectoral fins, or an ecological affinity to shelter in the stream bottom/margin. All but the white sucker feed on invertebrates either on the bottom or in the drift. White suckers are omnivores consuming a wide variety of plant, animal, and detrital materials. Blacknose dace are an extremely common stream fish and are considered tolerant of a wide variety of water conditions. Darters and suckers, on the other hand, are often considered to be characteristic of higher quality habitat conditions. All trout are valued by recreationally anglers although wild (naturally reproducing) are often prized more highly than hatchery fish. Trout typically inhabit well-oxygenated pools of relatively clean rivers and feed off benthic invertebrates that occur in the drift. Only one species, the golden shiner of the family Cyprinidae, occurred in Cat Swamp Pond. This species was extremely numerous and likely this small system cannot maintain this density. None of these species at Morristown are threatened, endangered, or of special concern. The stream systems at this park appear to be healthy systems with natural reproduction and should be maintained.

Previous records

Previous sampling records are useful to determine the potential species pool. However, less common and highly variable (but not necessarily rare/threatened/endangered) species may not be caught in every inventory effort because of variability and chance not because these species are decreasing in abundance. These less common and highly variable species often comprise a substantial portion of any animal community (i.e., this is the basis for the lognormal distribution of species often used in theoretical models). The catch of these less common and highly variable species is exacerbated by different sampling methodologies and levels of effort. Hence, it is difficult to draw conclusions about changes in freshwater fish communities from occasional surveys. This is why we recommend repeating the same type of sampling at the same sites at the same effort levels for several years to get a baseline species list. Once this is established, changes through time can be interpreted with increased confidence.

We compiled previous information on fish sampling. Limited formal surveys have documented fish communities at Morristown in the past so limited comparisons are possible. In both the past survey and the present one, bluegill, brook trout, brown trout, rainbow trout, golden shiner, spottail shiner, tesselated darter, and white sucker were found. In the present survey, we did not find creek chubsucker, mottled sculpin, redbreast sunfish, or smallmouth bass. Blacknose dace, creek chub, slimy sculpin were absent in the past but present in our survey.

Anthropogenic Effects

Land Use

A major source of anthropogenic effects are those associated with changing land use. As the amount of forest is decreased and as development and/or agriculture increase, a number of effects can occur that can have adverse effects on freshwater fish. First, as the amount of vegetation decreases, the hydrograph changes. Often more water flows over land and less percolates into the ground water. As a result, extreme flow conditions increase and both floods and droughts are exacerbated. This change in water quantity and especially the variation in water quality can have adverse effects on many fish. Second, roads and other paved areas will increase runoff. Third, a change in riparian corridor can have adverse effects on stream water quality. The resulting increased runoff from development, roads, and an altered riparian area can increase the amount of sediment, nutrients, salt, and car oil in the lakes and streams. A decrease in water quality can, of course, have an adverse effect on freshwater fish by affecting basic physiology/metabolism, increasing disease, and affecting spawning and egg development. Changes in land use should be monitored for the watershed in which the park resides. If land use changes, water quality, sediment, and incidence of disease should be monitored. Seasonal flow regimes should also be documented.

Contaminants

Contaminants from industry can have an adverse effect on fish physiology. In areas where contaminants are know to exist, water quality, contaminant loads, and fish communities should be carefully watched.

Animals that affect vegetation and water flow. Beaver and deer are increasing in many suburban/urban areas. Beaver, by damming streams, can slow/stop flow and change the community from a flowing system to a standing water one. Deer can overgraze riparian areas and cause increased sedimentation and runoff. If either of these animals is common in the area of the park, water quality, flow regime, and fish communities should be carefully monitored.

Dams

Dams are an integral part of many northeastern systems. If drawdown is planned to repair dams, care should be taken not to adversely affect those fish that live in the impoundment margin. This can be done by simply watching how much inshore substrate is dewatered by the drawdown. If possible, avoid drawdown in spring when sunfish are building nests in the shallows.

Stocking, Visitation, and Invading Species

Adding new species to any system can affect existing species. Often with increased human activity, species are transplanted between water bodies. Visitors should be warned about the dangers of this. Stocking should be relegated to tested programs. Monitoring fish species composition should alert the park to new species.

Vegetation

In many systems, aquatic vegetation is critical to fish community structure. Changes in vegetation could change the fish communities drastically. Changes in water quality, nutrients, and other factors that affect aquatic vegetation should be monitored as should the vegetation itself and the fish communities that use it.

All of these effects could be important in any of the NPS sites in the northeast. All parks are potentially affected by changing land use, changes in water quantity/quality, nutrient enrichment from urbanization and farming, and runoff from roads.

Future Work

A good effort was expended in sampling Morristown. Although, it is unlikely that any limited sampling will capture all species, especially rare species, we think that we sampled a representative portion of the species. Electrofishing at index sites should provide a good index of changes in species in these flowing water systems. Our recommendation is that the northeast parks band together and institute a sampling plan where they work together as a team to sample each park for fish every other year. Future efforts should be expended fine tuning the standardized effort of gear used and the target reference system for the park.

Results for Roosevelt-Vanderbilt National Historic Site

Freshwater Habitats

Roosevelt-Vanderbilt National Historic Site (ROVA) contains 10 aquatic resources with freshwater fish within three locations: Eleanor Roosevelt Site: Upper Valkill Pond, Lower Valkill Pond, Fall Kill Creek; Franklin Roosevelt Site: Meriches Kill, Roosevelt Ice Pond, Roosevelt Cove; Vanderbilt Site: Crum Elbow Creek, Upper Pond, Middle Pond, Lower Pond (Figures 27-29). These resources include low flow impoundments (Upper Valkill Pond, Lower Valkill Pond, Roosevelt Cove), high flow impoundments (Roosevelt Ice Pond, Vanderbilt Upper Pond, Middle Pond, Lower Pond), lower gradient streams (Fall Kill Creek, Meriches Kill), moderate gradient streams (Meriches Kill), and higher gradient streams (Meriches Kill, Crum Elbow Creek) (Figures 30-32). Small ponds are standing water systems with no dams. Low flow impoundments are bodies of water formed by manmade dams resulting in small ponds or lakes with limited inflow and outflow. High flow impoundments are bodies of water formed by a man-made dams resulting in small lakes or ponds with substantial inflow and outflow often at high current velocities. Low gradient streams are defined as slower moving soft bottomed systems with many large pools. Moderate gradient streams are defined as faster moving, gravel and cobble bottomed systems with riffles and runs. Higher gradient streams are defined as extremely fast moving, rock to boulder bottomed systems with runs, falls, and plunge pools. Of the 10 aquatic resources at ROVA, all resources were sampled except Lower Fallkill Pond, Roosevelt Ice Pond, Roosevelt Cove, Vanderbilt Lower Pond. These were not sampled because of difficult access or other logistic constraints.

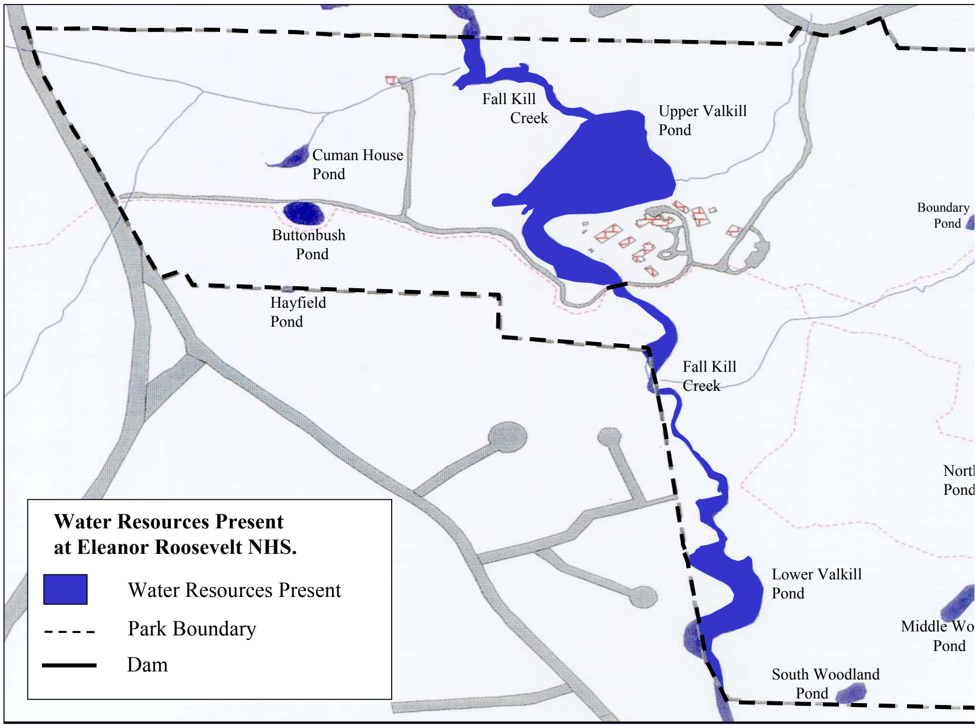

Figure 27. Water resources present at Eleanor Roosevelt NHS.

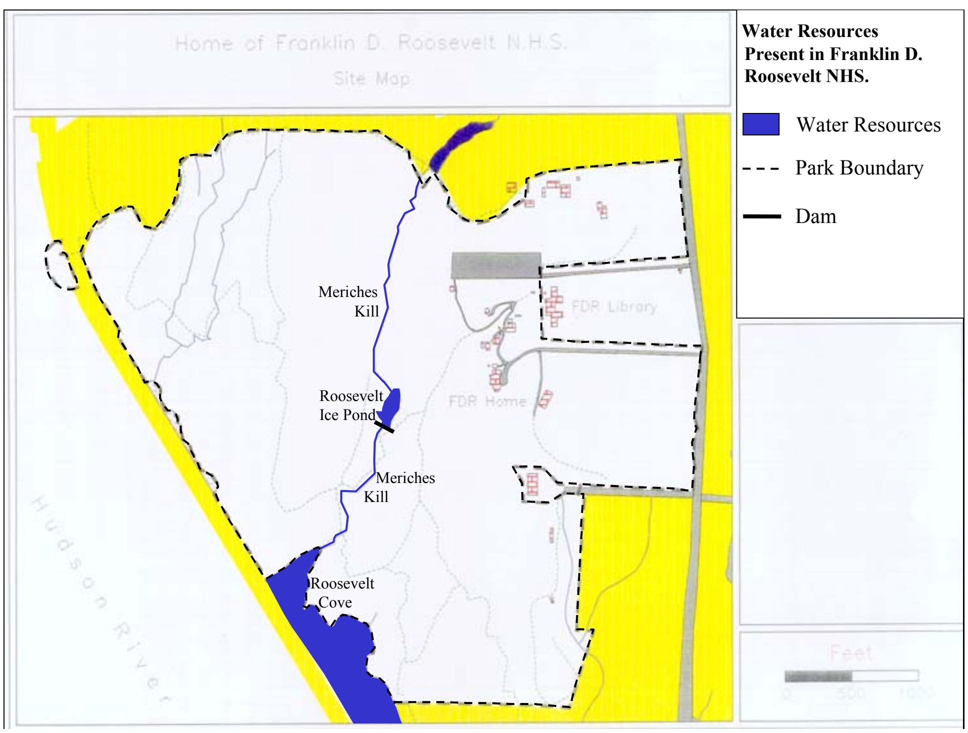

Figure 28. Water resources present at Franklin D. Roosevelt NHS.

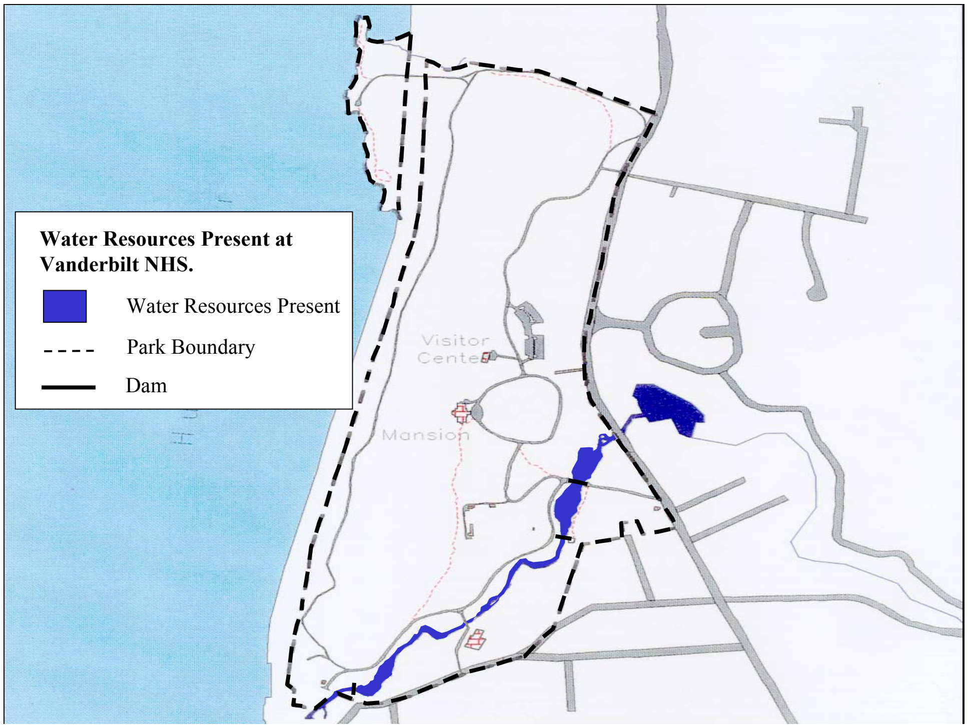

Figure 29. Water resources present at Vanderbilt NHS.

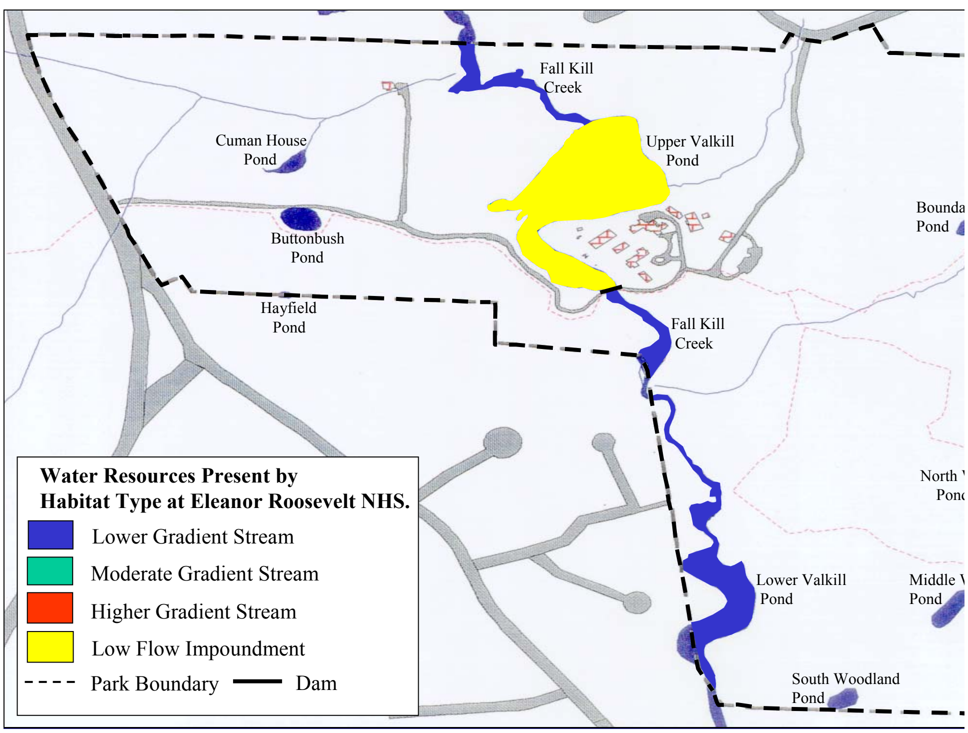

Figure 30. Water resources by habitat type at Eleanor Roosevelt NHS.

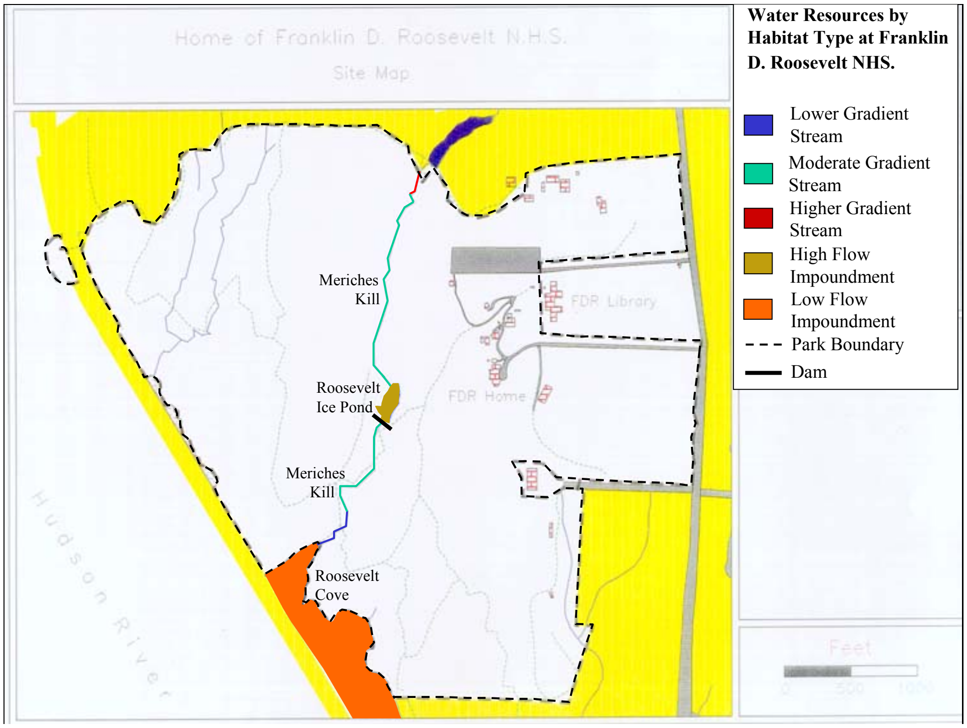

Figure 31. Water resources by habitat type at Franklin D. Roosevelt NHS.

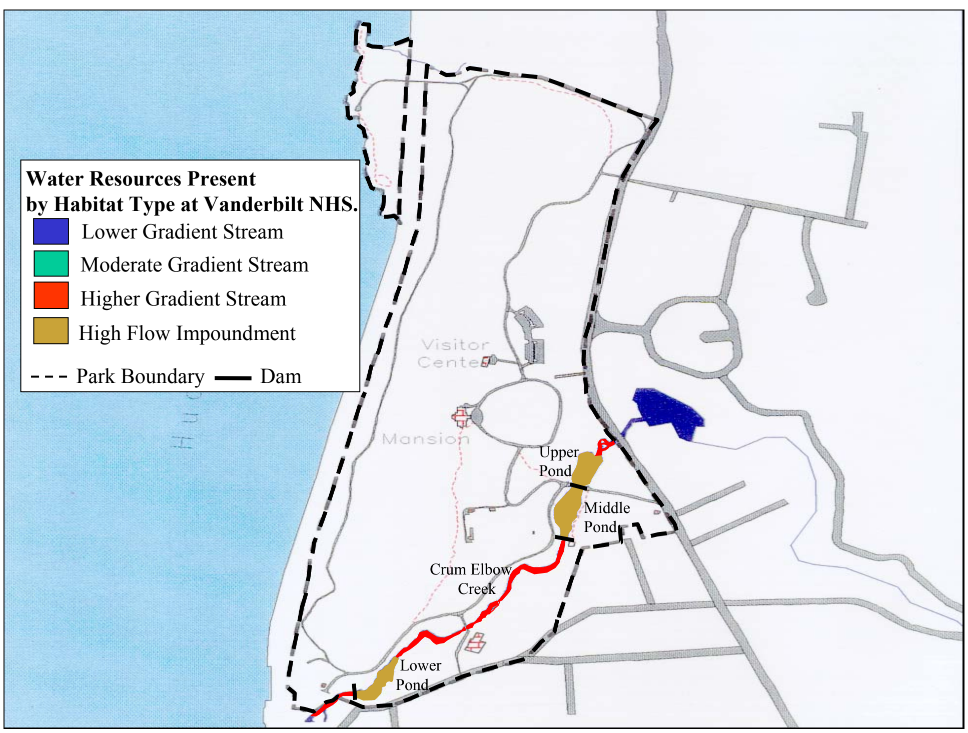

Figure 32. Water resources by habitat type at Vanderbilt NHS.

Sampling Intensity

Habitats at ROVA were surveyed in October, 1999. This system was sampled for fish in October, 2000. During the four days of sampling, 5 habitat types at 6 of 10 resources were sampled at 16 sites resulting in 76 units of effort/pieces of gear (Figures 33-35). Of this, 15 units of stream habitat were sampled at 5 sites using a backpack electrofisher (Crum Elbow, Meriches Kill). This sampling covered 2-28% of the total flowing water habitat. Fall Kill Creek, a lower gradient stream, could only be sampled with a beach seine (one resource, one site, one unit of effort). During this same sampling period, the low flow impoundment habitat (Valkill Pond) was sampled at 8 sites with 56 units of effort unit using the traditional standing water gear (3 fyke nets, 15 minnow traps, 1 trammel net) set twice and a reduced set of traditional standing water gear set once (3 fyke nets, 15 minnow traps). A beach seine was the only gear that could be used to safely sample the high flow impoundment habitat represented by the Vanderbilt Upper and Middle ponds (2 resources, 2 sites, 2 units of effort/gear) (Figures 36-38).

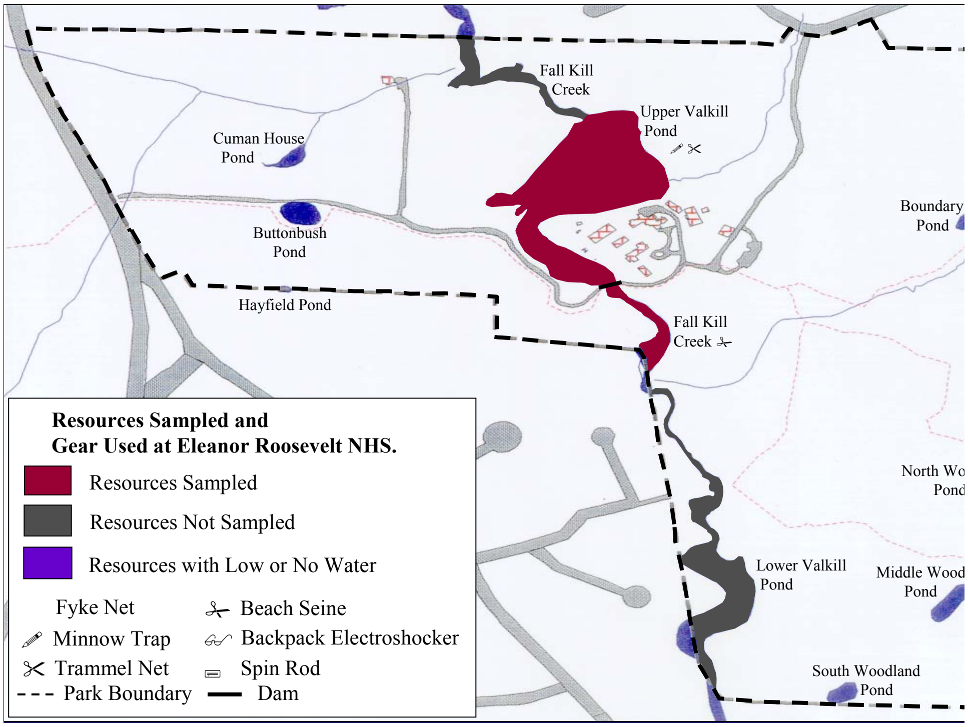

Figure 33. Resources sampled and gear used at Eleanor Roosevelt NHS.

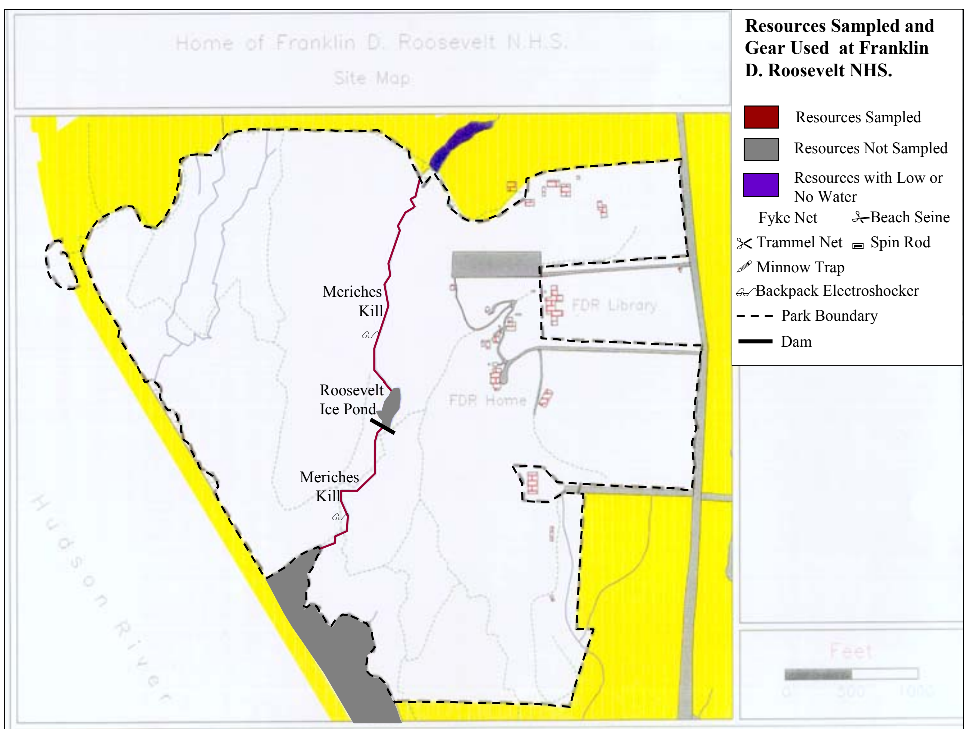

Figure 34. Resources sampled and gear used at Franklin D. Roosevelt NHS.

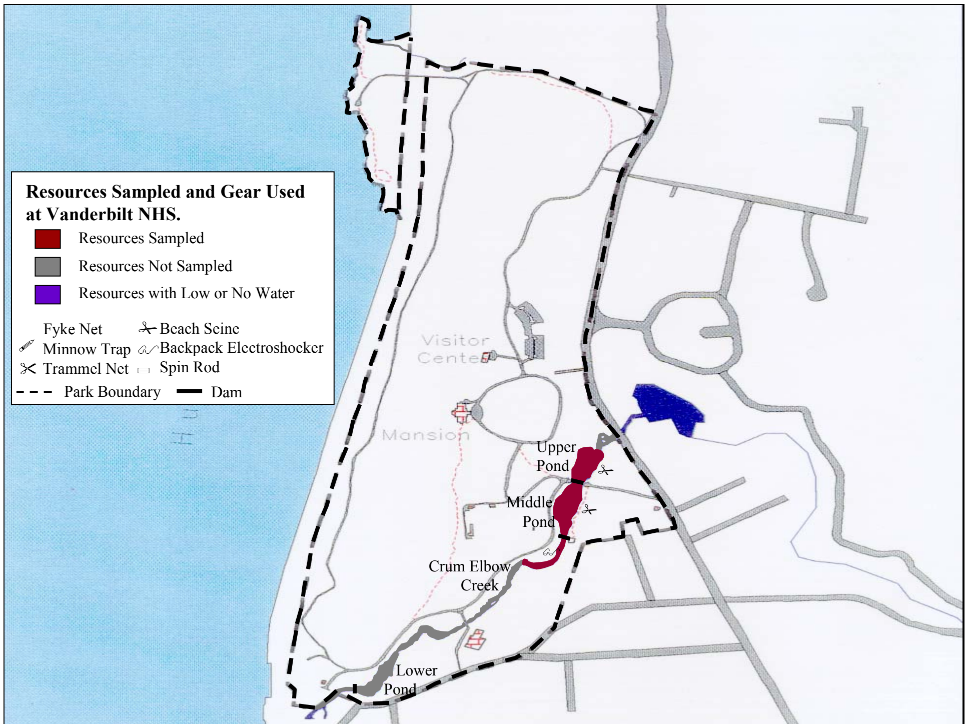

Figure 35. Resources sampled and gear used at Vanderbilt NHS.

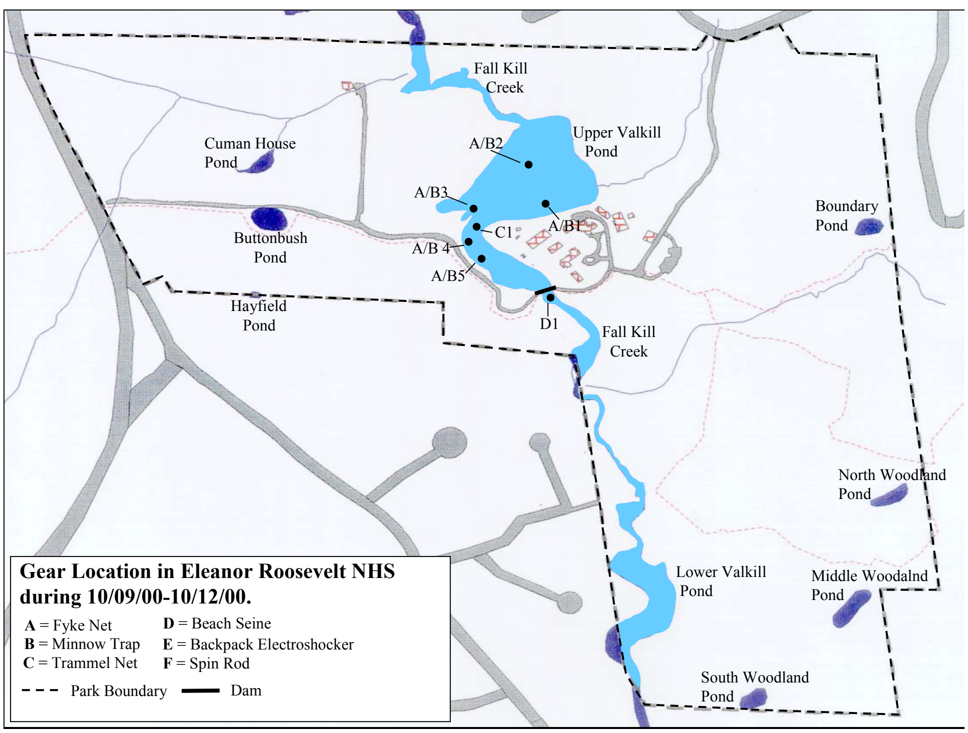

Figure 36. Gear location at Eleanor Roosevelt NHS.

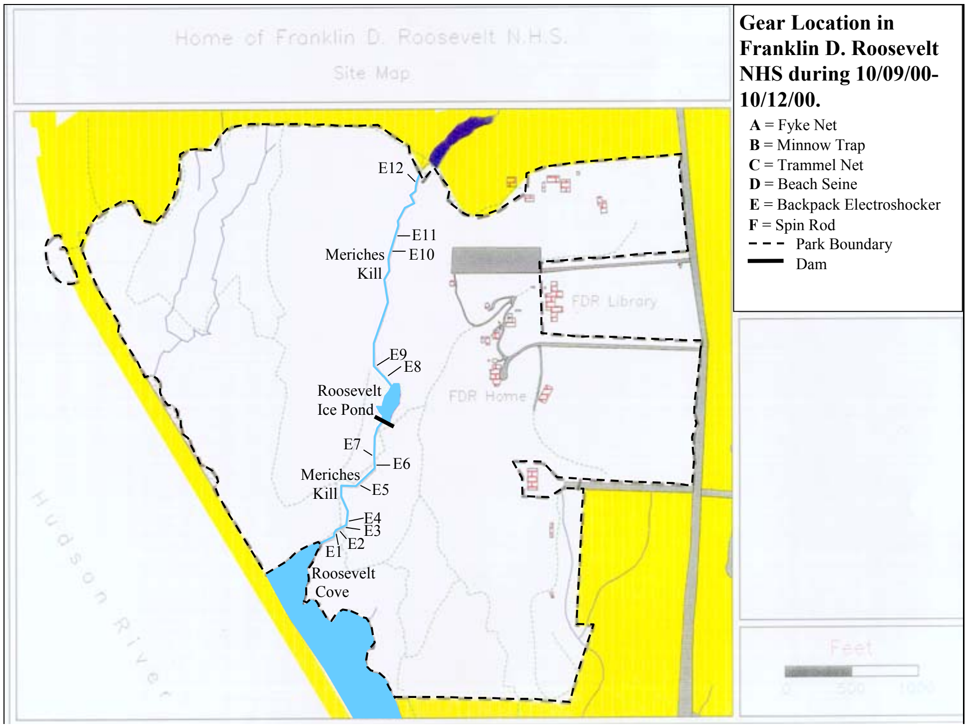

Figure 37. Gear location at Franklin D. Roosevelt NHS.

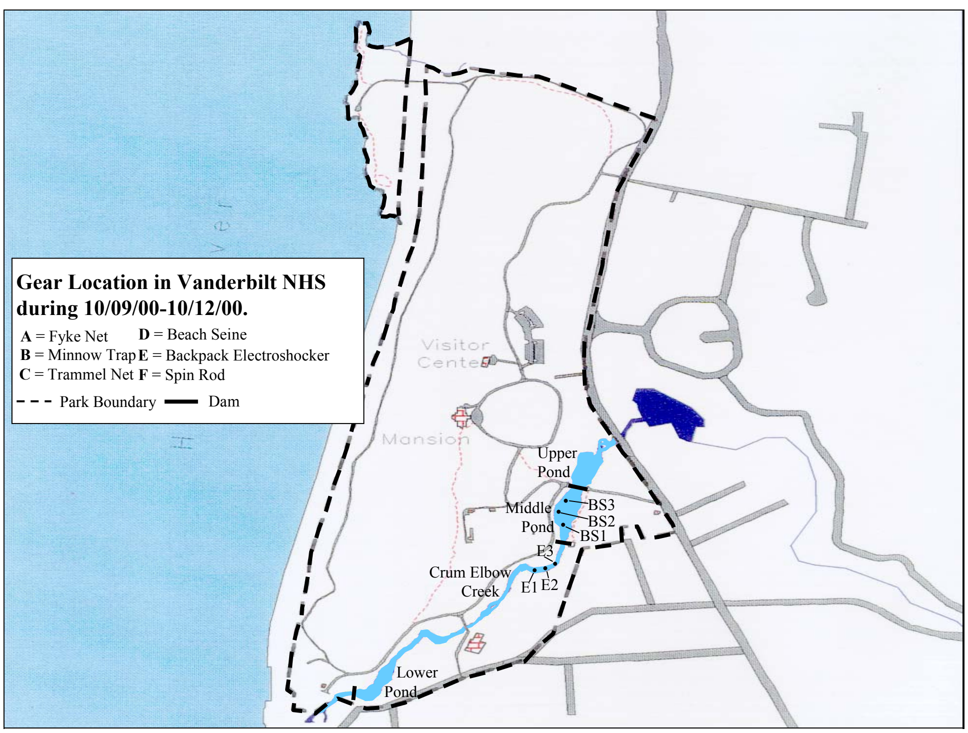

Figure 38. Gear location at Vanderbilt NHS.

The fish community

Overall, Roosevelt-Vanderbilt NHS contained 18 species: American eel, banded killifish, blacknose dace, bluegill sunfish, brown bullhead, chain pickerel, common shiner**,** creek chub, cutlips minnow, golden shiner, johnny darter, largemouth bass, mummichog, pumpkinseed sunfish, redbreast sunfish, redfin pickerel, rock bass, and white sucker (Figure 39). These species represented 8 families: Anguillidae: American eel; Fundulidae: banded killifish, mummichog; Cyprinidae:, blacknose dace, common shiner, creek chub, cutlips minnow, golden shiner; Centrarchidae: bluegill sunfish, largemouth bass, redbreast sunfish, pumpkinseed sunfish, rock bass; Esocidae: chain pickerel, redfin pickerel; Ictaluridae: brown bullhead; Percidae: johnny darter; Catastomidae: white sucker. Of these, all but bluegill sunfish and rock bass are native. These two non-native species but have been in many northeastern systems for over a hundred years, are naturally reproducing, and generally not considered a threat to native biodiversity.

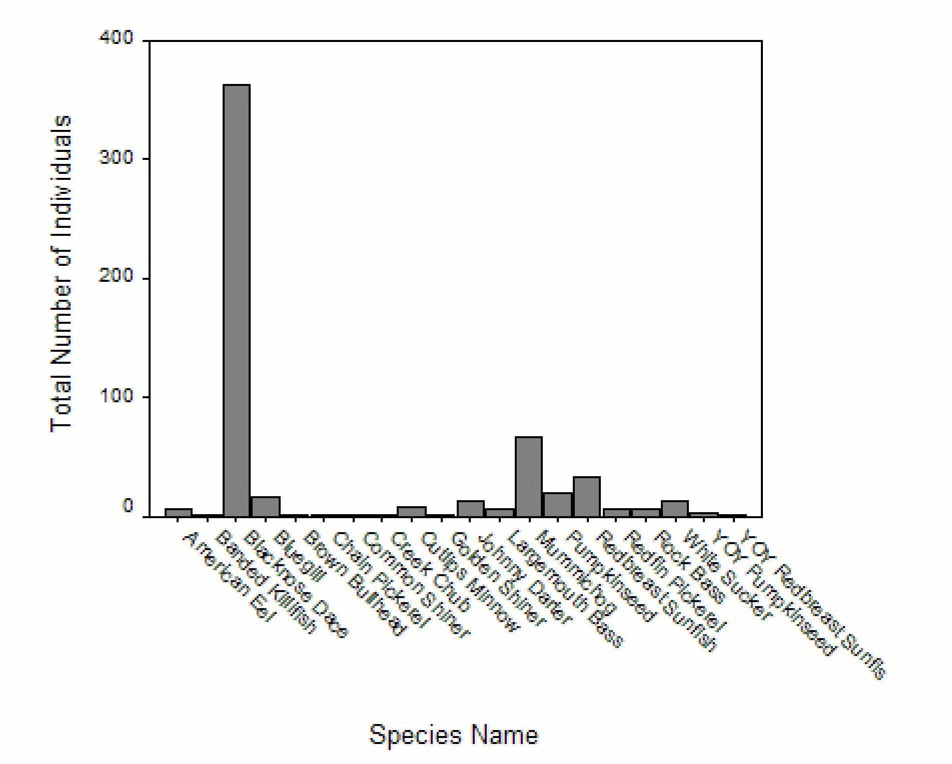

Figure 39. Species and total number of individuals detected at Roosevelt-Vanderbilt NHS.

Summary

Banded killifish are small-bodied pelagic planktivores typically occupying slower moving, unvegetated systems. Blacknose dace, common shiner, creek chub, cutlips minnow, johnny darter, and white sucker are typical stream fish. Their adaptations to living in flowing water include either a flattered body or an ecological affinity to shelter in the stream bottom or stream edge. All but the white sucker feed on invertebrates from the bottom or the drift. White suckers are omnivores consuming a wide variety of bottom materials. Blacknose dace are an extremely common stream fish and are considered tolerant of a wide variety of water conditions. Darters and suckers, on the other hand, are often considered to be characteristic of higher quality habitat conditions. Golden shiners are planktivores found in both lakes and streams although most often lakes. Bluegill sunfish typically are found in slow moving or standing water and typically consume plankton but will also eat small benthic invertebrates. The omnivorous brown bullhead are also typically found in slower water, mostly standing water, systems. Pumpkinseed sunfish, red-breasted sunfish, and rock bass are centrarchids that occupy both standing and flowing water systems. Largemouth bass and chain pickerel most often occupy slow moving water and were found primarily in the edge habitat of the high flow impoundments. Mummichog are relatives of the banded killifish and typically feed on benthos in estuarine habitats. None of these species are threatened, endangered, or of special concern.

At Roosevelt-Vanderbilt NHS, banded killifish, blacknose dace, common shiner, creek chub, cutlips minnow, golden shiner, johnny darter, and mummichog were found only in streams. Banded killifish, johnny darter, and mummichog were found only in low gradient streams. Creek chub and golden shiner were found only in medium gradient streams. Common shiner and cutlips minnow were found only in high gradient streams. Blacknose dace were found in low, medium, and high gradient streams. Bluegill sunfish, brown bullhead, chain pickerel, largemouth bass, and rock bass were found only in impoundments. Chain pickerel and largemouth bass were found only in high impoundments. Rock bass were found in both low and high gradient impoundments. Pumpkinseed and red breast sunfish were found in higher gradient streams and low flow impoundments. Redfin pickerel were found in low gradient streams and both types of impoundments. White sucker were found in slower water low gradient impoundments and low and medium gradient streams. Across all habitats, blacknose dace were extremely common and numbers of banded killifish, brown bullhead, chain pickerel, common shiner, creek chub were found in low numbers (Table 10).

Table 10. Roosevelt-Vanderbilt NHS sampling locations, habitat types, and number of species identified.

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
Crum Elbow Creek	Higher gradient stream	American Eel	3	3.00	.
		Blacknose Dace	32	10.67	7.02
		Common Shiner	1	1.00	.
		Cutlips Minnow	9	3.00	1.00
		Redbreast Sunfish	8	4.00	4.24
		Rock Bass	3	3.00	.
Lower Fallkill Creek	Lower gradient stream	Redbreast Sunfish	1	1.00	.
		Redfin Pickerel	1	1.00	.
Meriches Kill	Higher gradient stream	Blacknose Dace	12	12.00	.
	Lower gradient stream	American Eel	3	3.00	.
		Banded Killifish	1	1.00	.
		Blacknose Dace	15	7.50	0.71
		Johnny Darter	13	6.50	3.54
		Mummichog	68	34.00	31.11
		Pumpkinseed	15	7.50	6.36
		Redbreast Sunfish	25	12.50	12.02
		Redfin Pickerel	1	1.00	.
		White Sucker	2	2.00	.
		YOY Pumpkinseed	3	1.50	0.71
	Moderate gradient stream	Blacknose Dace	304	43.43	24.64
		Creek Chub	1	1.00	.
		Golden Shiner	2	2.00	.
		White Sucker	4	2.00	1.41
Middle Pond	High flow impoundment	Largemouth Bass	2	1.00	0.00
		No Fish	0	0.00	.
		Pumpkinseed	1	1.00	.
		YOY Redbreast Sunfish	1	1.00	.
Upper Pond	High flow impoundment	Chain Pickerel	1	1.00	.
		Largemouth Bass	4	4.00	.
		Pumpkinseed	4	4.00	.

Table 10. Roosevelt-Vanderbilt NHS sampling locations, habitat types, and number of species identified (continued).

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
		Redfin Pickerel	2	2.00	.
		Rock Bass	2	2.00	.
		YOY Redbreast Sunfish	1	1.00	.
Upper Valkill Pond	Low flow impoundment	Bluegill	17	8.50	9.19
		Brown Bullhead	1	1.00	.
		No Fish	0	0.00	0.00
		Redfin Pickerel	2	1.00	0.00
		Rock Bass	1	1.00	.
		White Sucker	7	3.50	0.71
Total	High flow impoundment	Chain Pickerel	1	1.00	.
		Largemouth Bass	6	2.00	1.73
		No Fish	0	0.00	.
		Pumpkinseed	5	2.50	2.12
		Redfin Pickerel	2	2.00	.
		Rock Bass	2	2.00	.
		YOY Redbreast Sunfish	2	1.00	0.00
	Higher gradient stream	American Eel	3	3.00	.
		Blacknose Dace	44	11.00	5.77
		Common Shiner	1	1.00	.
		Cutlips Minnow	9	3.00	1.00
		Redbreast Sunfish	8	4.00	4.24
		Rock Bass	3	3.00	.
	Low flow impoundment	Bluegill	17	8.50	9.19
		Brown Bullhead	1	1.00	.
		No Fish	0	0.00	0.00
		Redfin Pickerel	2	1.00	0.00
		Rock Bass	1	1.00	.
		White Sucker	7	3.50	0.71
	Lower gradient stream	American Eel	3	3.00	.
		Banded Killifish	1	1.00	.
		Blacknose Dace	15	7.50	0.71

Table 10. Roosevelt-Vanderbilt NHS sampling locations, habitat types, and number of species identified (continued).

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
		Johnny Darter	13	6.50	3.54
		Mummichog	68	34.00	31.11
		Pumpkinseed	15	7.50	6.36
		Redbreast Sunfish	26	8.67	10.79
		Redfin Pickerel	2	1.00	0.00
		White Sucker	2	2.00	.
		YOY Pumpkinseed	3	1.50	0.71
	Moderate gradient stream	Blacknose Dace	304	43.43	24.64
		Creek Chub	1	1.00	.
		Golden Shiner	2	2.00	.
		White Sucker	4	2.00	1.41

These species cover a range of ecological roles. Banded killifish and golden shiner are plantivorous, feeding on planktonic invertebrates. A number of species including blacknose dace, bluegill sunfish, common shiner, creek chub, cutlips minnow, johnny darter, mummichog, pumpkinseed sunfish, red-breasted sunfish, and rock bass, feed on both planktonic and benthic invertebrates. Although these invertivores are all diet generalists, some species, like bluegill, have a preference for zooplankton while others, like pumpkinseed, have morphological adaptations that allow them to thrive on benthos. Chain pickerel, largemouth bass, and redfin pickerel are piscivorous predators. Species like rock bass and American eel, if large enough, consume fish. American eel, brown bullhead, and white sucker have omnivorous eating habits.

Previous records

Previous sampling records are useful to determine the potential species pool. However, less common and highly variable (but not necessarily rare/threatened/endangered) species may not be caught in every inventory effort because of variability and chance not because these species are decreasing in abundance. These less common and highly variable species often comprise a substantial portion of any animal community (i.e., this is the basis for the lognormal distribution of species often used in theoretical models). The catch of these less common and highly variable species is exacerbated by different sampling methodologies and levels of effort. Hence, it is difficult to draw conclusions about changes in freshwater fish communities from occasional surveys. This is why we recommend repeating the same type of sampling at the same sites at the same effort levels for several years to get a baseline species list. Once this is established, changes through time can be interpreted with increased confidence.

We compiled previous information on fish sampling. Limited surveys have documented fish communities at ROVA. The most recent survey, Schmidt (1995), found most of the species we did (golden shiner, white sucker, redfin pickerel, rock bass, red breasted sunfish, bluegill, largemouth bass, American eel, cutlips minnow, blacknose dace, largemouth bass, pumpkinseed sunfish). He also found banded killifish and mummichog in the salt marsh, Roosevelt Cove, whereas we found them in the freshwater Meriches Kill. We report five new species, i.e., brown bullhead, chain pickerel (both of which were previously reported), as well as common shiner, creek chub, and johnny darter. Schmidt reports catching black crappie, a fish we did not see. He also caught a number of salt marsh fish in Roosevelt Cove, a habitat we did not sample because of its estuarine nature. We recommend waiting to evaluate these changes until a basic species pool has been established by repetitive standardized sampling.

Anthropogenic Effects

Land Use

A major source of anthropogenic effects are those associated with changing land use. As the amount of forest is decreased and as development and/or agriculture increase, a number of effects can occur that can have adverse effects on freshwater fish. First, as the amount of vegetation decreases, the hydrograph changes. Often more water flows over land and less percolates into the ground water. As a result, extreme flow conditions increase and both floods and droughts are exacerbated. This change in water quantity and especially the variation in water quality can have adverse effects on many fish. Second, roads and other paved areas will increase runoff. Third, a change in riparian corridor can have adverse effects on stream water quality. The resulting increased runoff from development, roads, and an altered riparian area can increase the amount of sediment, nutrients, salt, and car oil in the lakes and streams. A decrease in water quality can, of course, have an adverse effect on freshwater fish by affecting basic physiology/metabolism, increasing disease, and affecting spawning and egg development. Changes in land use should be monitored for the watershed in which the park resides. If land use changes, water quality, sediment, and incidence of disease should be monitored. Seasonal flow regimes should also be documented.

Contaminants

Contaminants from industry can have an adverse effect on fish physiology. In areas where contaminants are know to exist, water quality, contaminant loads, and fish communities should be carefully watched.

Animals that affect vegetation and water flow

Beaver and deer are increasing in many suburban/urban areas. Beaver, by damming streams, can slow/stop flow and change the community from a flowing system to a standing water one. Deer can overgraze riparian areas and cause increased sedimentation and runoff. If either of these animals is common in the area of the park, water quality, flow regime, and fish communities should be carefully monitored.

Dams

Dams are an integral part of many northeastern systems. If drawdown is planned to repair dams, care should be taken not to adversely affect those fish that live in the impoundment margin. This can be done by simply watching how much inshore substrate is dewatered by the drawdown. If possible, avoid drawdown in spring when sunfish are building nests in the shallows.

Stocking, Visitation, and Invading Species

Adding new species to any system can affect existing species. Often with increased human activity, species are transplanted between water bodies. Visitors should be warned about the dangers of this. Stocking should be relegated to tested programs. Monitoring fish species composition should alert the park to new species.

Vegetation

In many systems, aquatic vegetation is critical to fish community structure. Changes in vegetation could change the fish communities drastically. Changes in water quality, nutrients, and other factors that affect aquatic vegetation should be monitored as should the vegetation itself and the fish communities that use it.

All of these effects could be important in any of the NPS sites in the northeast. All parks are potentially affected by changing land use, changes in water quantity/quality, nutrient enrichment from urbanization and farming, and runoff from roads.

Future Work

A good effort was expended in sampling Roosevelt-Vanderbilt NHS. Although, it is unlikely that any limited sampling will capture all species, especially, rare species, we think that we sampled a representative portion of the species. Electrofishing at flowing water index sites and a regular effort of nets and traps should provide a good index of changes in species in these systems. Our recommendation is that the northeast parks band together and institute a sampling plan where they work together as a team to sample each park for fish every other year. Future efforts should be expended fine tuning the standardized effort of gear used and the target reference system for the park.

Results for Saint-Gaudens National Historic Site

Freshwater Habitats

Saint-Gaudens National Historic Site (SAGA) contains four aquatic resources with freshwater fish: Blow-Me-Down Pond, Blow-Me-Down Brook, Blow-Me-Up Brook, and Farm Pond (Figure 40). These resources include low flow impoundments/small ponds (Farm Pond), high flow impoundments (Blow-Me-Down Pond), lower gradient streams (Blow-Me-Down Brook), moderate gradient stream habitat (Blow-Me-Up Brook) and higher gradient streams (Blow-Me-Down Brook, Blow-Me-Up Brook) (Figure 41). Low flow impoundments are bodies of water with a man-made dam that form a small pond or lake with minimal inflow and outflow. Ponds are similar small standing water systems that have no dam. Lower gradient streams are slower moving, soft-bottomed systems with many large pools. Moderate gradient streams are defined as faster moving, gravel/cobble bottomed systems, with riffles and runs. Higher gradient streams are extremely fast moving, rock to boulder bottomed systems, with runs, falls, and plunge pools. Defining habitat type is important for both the selection of effective sampling gear and to identify potential fish communities.

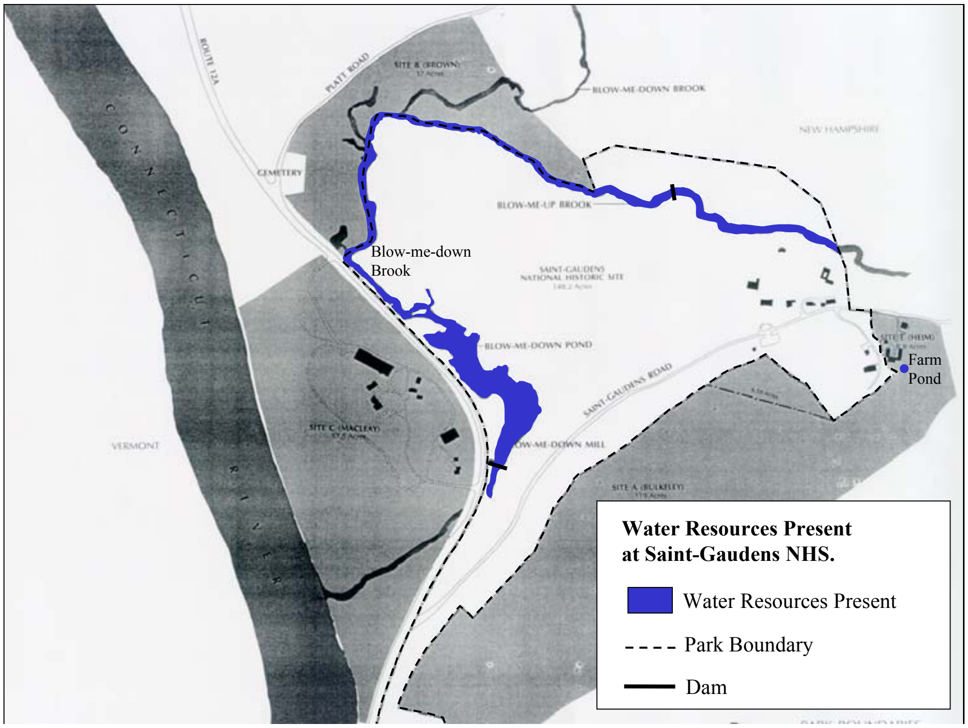

Figure 40. Water resources present at Saint-Gaudens NHS.

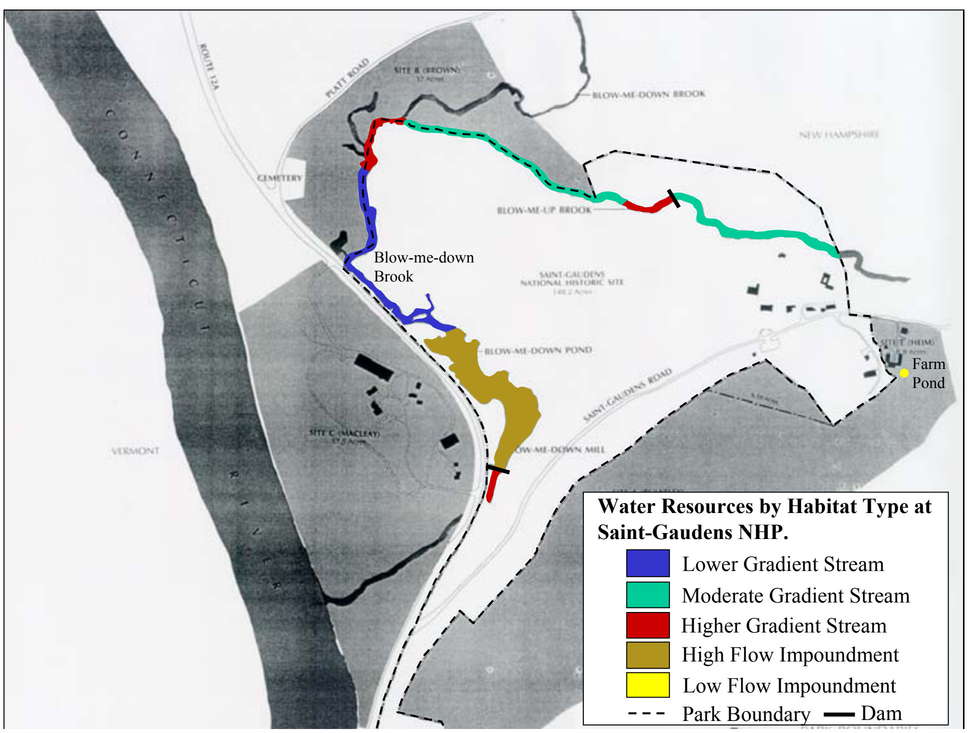

Figure 41. Water resources by habitat type at Saint-Gaudens NHS.

Sampling Intensity

Habitats at Saint-Gaudens were surveyed in October, 1999. This system was sampled for fish in October, 2000. We tried to sample habitat types with a standard, repetitive effort. However, sometimes the standard effort had to be modified because of system size, bottom type, or other constraints. In general, we sampled low, medium, and high gradient streams in 25 m transects repeated until our catch curve flattened out, i.e., no or few new species caught or 10% of the habitat was sampled. In general, ponds and low flow impoundments were sampled with repetitions of 15 minnow traps and three fyke nets. When the system was large enough, a trammel net was used. In the atypical circumstances in which bottoms were hard and smooth, a beach seine was also included. In smaller systems, this standardized suite of gear was reduced to 1 fyke net and 15 minnow traps.

During the three days of sampling, 15 sites within four resources representing four habitat types were sampled with a total of 91 units of effort/gear (Figure 42). Of these, 18 units of stream habitat (Blow-Me-Up and Blow-Me-Down Brooks) were sampled using a backpack electrofisher in replicates of 25 m. This effort surveyed 17-21% of the total flowing water habitat. During this same sampling period, the two impoundment/small pond resources were sampled at 11 sites representing 73 units of effort. Blow-Me-Down Pond was sampled three times with the traditional standing water gear (3 fyke nets, 15 minnow traps, 1 trammel net). A more limited suite of gear, i.e., 1 fyke net and 15 minnow traps, was used once to sample the smaller farm pond (Figure 43).

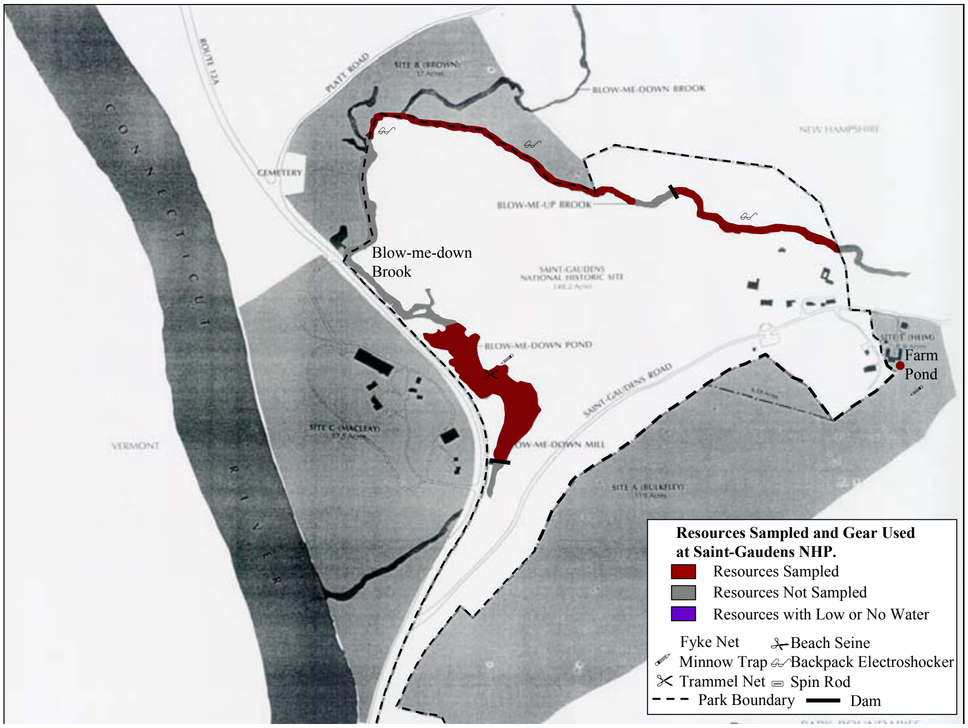

Figure 42. Resources sampled and gear used at Saint-Gaudens NHS.

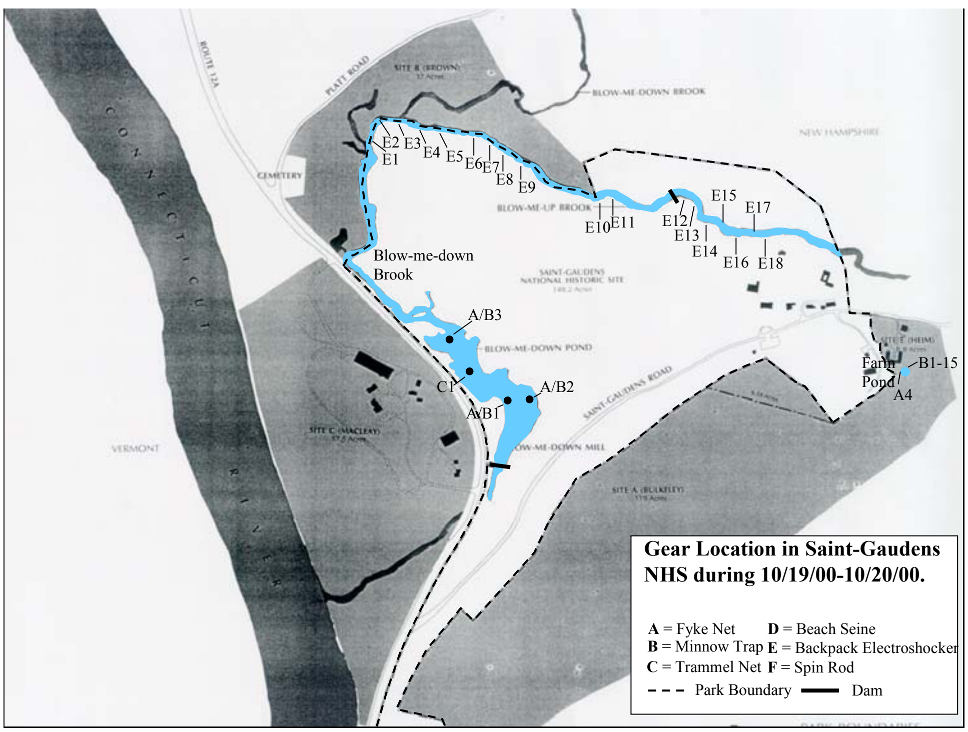

Figure 43. Gear location at Saint-Gaudens NHS.

The Fish community

Overall, Saint-Gaudens contained 12 freshwater fish species: blacknose dace, brook trout, brown bullhead , common shiner, creek chub, fallfish, golden shiner, longnose dace, pumpkinseed sunfish, slimy sculpin, spottail shiner, and white sucker (Figure 44). These species represented six families: Cyprinidae (common shiner, blacknose dace, creek chub, fallfish, golden shiner, longnose dace, spottail shiner); Salmonidae (brook trout); Ictaluridae (brown bullhead), Centrarchidae (pumpkinseed sunfish), Cottidae (slimy sculpin), and Catastomidae (white sucker). All of these are native.

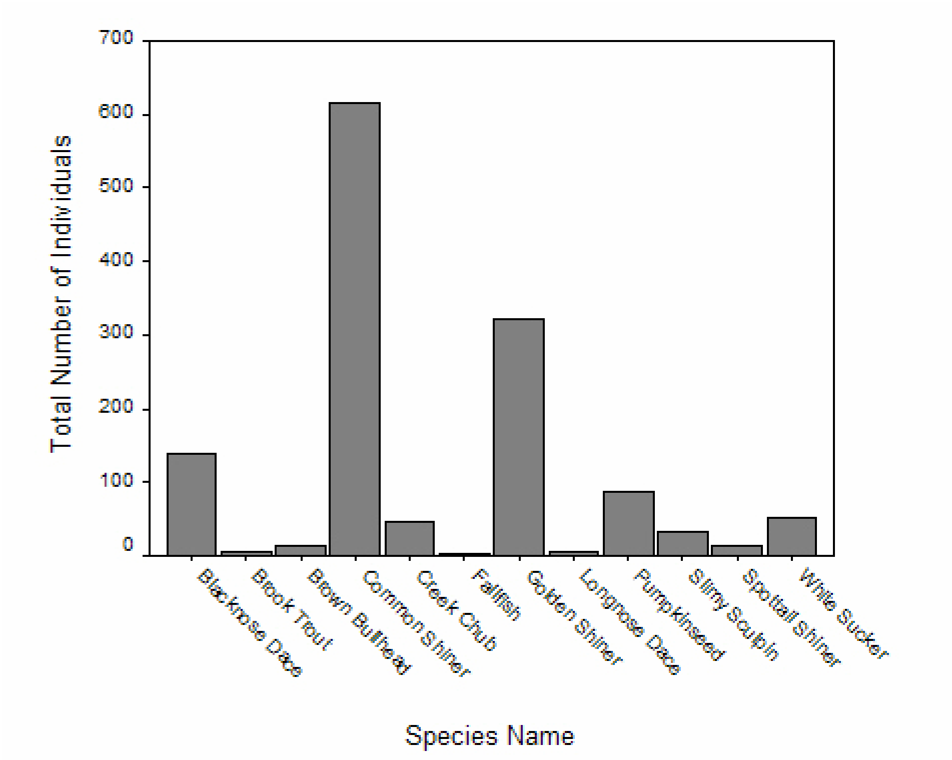

Figure 44. Species and total number of individuals detected at Saint-Gaudens NHS.

No fish were caught in the small farm pond. Brook trout and slimy sculpin were found in the medium gradient stream habitat. Longnose dace and spottail shiner were found in both moderate and high gradient stream habitats. Brown bullhead, golden shiner, and creek chub were found in the high flow impoundment. Blacknose dace and white sucker were found in the high flow impoundment, moderate gradient and high gradient stream whereas fallfish were found in the high flow impoundment and moderate gradient stream habitat. Common shiners and pumpkinseed were found in the high flow impoundment and high gradient stream habitats (Table 11).

Table 11. Saint-Gaudens NHS sampling locations, habitat types, and number of species identified.

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
Blow-me-down Brook	Higher gradient stream	Blacknose Dace	88	44.00	48.08
		Common Shiner	30	30.00	.
		Longnose Dace	5	2.50	0.71
		Pumpkinseed	1	1.00	.
		Spottail Shiner	8	4.00	0.00
		White Sucker	15	7.50	3.54
Blow-me-down Pond	High flow impoundment	Blacknose Dace	4	2.00	0.00
		Brown Bullhead	14	2.33	1.75
		Common Shiner	586	36.63	37.26
		Creek Chub	47	5.22	4.18
		Fallfish	3	1.00	0.00
		Golden Shiner	322	32.20	38.52
		No Fish	0	0.00	0.00
		Pumpkinseed	87	7.91	4.87
		White Sucker	37	3.70	4.19
Blow-me-up Brook	Moderate gradient stream	Blacknose Dace	46	4.60	3.24
		Brook Trout	6	2.00	1.73
		Fallfish	1	1.00	.
		Longnose Dace	1	1.00	.
		No Fish	0	0.00	0.00
		Slimy Sculpin	34	4.25	2.82
		Spottail Shiner	5	1.00	0.00
		White Sucker	1	1.00	.
Farm Pond	Low flow impoundment	No Fish	0	0.00	0.00
Total	High flow impoundment	Blacknose Dace	4	2.00	0.00
		Brown Bullhead	14	2.33	1.75
		Common Shiner	586	36.63	37.26
		Creek Chub	47	5.22	4.18
		Fallfish	3	1.00	0.00
		Golden Shiner	322	32.20	38.52

Table 11. Saint-Gaudens NHS sampling locations, habitat types, and number of species identified (continued).

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
		No Fish	0	0.00	0.00
		Pumpkinseed	87	7.91	4.87
		White Sucker	37	3.70	4.19
	Higher gradient stream	Blacknose Dace	88	44.00	48.08
		Common Shiner	30	30.00	.
		Longnose Dace	5	2.50	0.71
		Pumpkinseed	1	1.00	.
		Spottail Shiner	8	4.00	0.00
		White Sucker	15	7.50	3.54
	Low flow impoundment	No Fish	0	0.00	0.00
	Moderate gradient stream	Blacknose Dace	46	4.60	3.24
		Brook Trout	6	2.00	1.73
		Fallfish	1	1.00	.
		Longnose Dace	1	1.00	.
		No Fish	0	0.00	0.00
		Slimy Sculpin	34	4.25	2.82
		Spottail Shiner	5	1.00	0.00
		White Sucker	1	1.00	.

Summary

Common shiner, blacknose dace, creek chub, fallfish, longnose dace, spottail shiner, and white sucker are typical stream fish. Their adaptations to living in flowing water include either a flattered body, large fins, or an ecological affinity to shelter in the stream bottom or edges. All but the white sucker feed on invertebrates either on the bottom or in the drift. White suckers are omnivores consuming a wide variety of bottom materials. Blacknose dace are an extremely common stream fish and are considered tolerant of a wide variety of water conditions. Suckers, on the other hand, are often considered to be characteristic of higher quality habitat conditions. The habitat requirements of cyprinids or minnow differ with the species. Golden shiners are planktivores found in both lakes and streams although most often lakes. The omnivorous brown bullhead are also typically found in slower, mostly standing water, systems. Pumpkinseed sunfish occupy both standing and flowing water systems often seeking out vegetation. Brook trout occupy pools of clean, relatively fast flowing water in hard-bottomed streams. None of these species are threatened, endangered, or of special concern. Across all habitats, blacknose dace, common shiner and golden shiner were very abundant (Table 11). Most species occurred in moderate abundance except the fallfish, of which only two were caught.

These species cover a range of ecological roles. Golden shiners are obligate planktivores. A number of species including blacknose dace, common shiner, creek chub, fallfish, longnose dace, pumpkinseed, slimy sculpin, and spottail shiners feed on invertebrates. Although these invertivores are all diet generalists, some species like pumpkinseed have morphological adaptations that allow them to thrive on benthos. Small brook trout can feed on invertebrate drift whereas large trout may consume small fish as well. Brown bullhead and white sucker have omnivorous eating habits.

Previous records

Previous sampling records are useful to determine the potential species pool. However, less common and highly variable (but not necessarily rare/threatened/endangered) species may not be caught in every inventory effort because of variability and chance not because these species are decreasing in abundance. These less common and highly variable species often comprise a substantial portion of any animal community (i.e., this is the basis for the lognormal distribution of species often used in theoretical models). The catch of these less common and highly variable species is exacerbated by different sampling methodologies and levels of effort. Hence, it is difficult to draw conclusions about changes in freshwater fish communities from occasional surveys. This is why we recommend repeating the same type of sampling at the same sites at the same effort levels for several years to get a baseline species list. Once this is established, changes through time can be interpreted with increased confidence.

We compiled previous information on fish sampling. The most recent survey by Cook found many of the same species we did (common shiner, blacknose dace, brook trout, brown bullhead, creek chub, fallfish, golden shiner, longnose dace, and common or white sucker). He also caught ten species we did not (chain pickerel, red belly dace, bluntnose minnow, rock bass, redbreasted sunfish, bluegill, yellow perch, and tessellated darter). Of these, bluntnose minnow, rock bass, redbreast sunfish, bluegill, yellow perch, and tesselated darter were relatively uncommon (1-8 individuals). We caught two new species, i.e, slimy sculpin and spottail shiner. Likely, with the proximity of the diverse Connecticut River, the SAGA systems may have constant additions and deletions to and from the local species pool. In our opinion, we should be careful about making too much of these comparisons until we have a baseline pool from a standardized, repetitive sampling**.**

Anthropogenic Effects

<u>Land Use</u>

A major source of anthropogenic effects are those associated with changing land use. As the amount of forest is decreased and as development and/or agriculture increase, a number of effects can occur that can have adverse effects on freshwater fish. First, as the amount of vegetation decreases, the hydrograph changes. Often more water flows over land and less percolates into the ground water. As a result, extreme flow conditions increase and both floods and droughts are exacerbated. This change in water quantity and especially the variation in water quality can have adverse effects on many fish. Second, roads and other paved areas will increase runoff. Third, a change in riparian corridor can have adverse effects on stream water quality. The resulting increased runoff from development, roads, and an altered riparian area can increase the amount of sediment, nutrients, salt, and car oil in the lakes and streams. A decrease in water quality can, of course, have an adverse effect on freshwater fish by affecting basic physiology/metabolism, increasing disease, and affecting spawning and egg development. Changes in land use should be monitored for the watershed in which the park resides. If land use changes, water quality, sediment, and incidence of disease should be monitored. Seasonal flow regimes should also be documented.

<u>Contaminants</u>

Contaminants from industry can have an adverse effect on fish physiology. In areas where contaminants are know to exist, water quality, contaminant loads, and fish communities should be carefully watched.

Animals that affect vegetation and water flow. Beaver and deer are increasing in many suburban/urban areas. Beaver, by damming streams, can slow/stop flow and change the community from a flowing system to a standing water one. Deer can overgraze riparian areas and cause increased sedimentation and runoff. If either of these animals is common in the area of the park, water quality, flow regime, and fish communities should be carefully monitored.

Dams

Dams are an integral part of many northeastern systems. If drawdown is planned to repair dams, care should be taken not to adversely affect those fish that live in the impoundment margin. This can be done by simply watching how much inshore substrate is dewatered by the drawdown. If possible, avoid drawdown in spring when sunfish are building nests in the shallows.

Stocking, Visitation, and Invading Species

Adding new species to any system can affect existing species. Often with increased human activity, species are transplanted between water bodies. Visitors should be warned about the dangers of this. Stocking should be relegated to tested programs. Monitoring fish species composition should alert the park to new species.

Vegetation

In many systems, aquatic vegetation is critical to fish community structure. Changes in vegetation could change the fish communities drastically. Changes in water quality, nutrients, and other factors that affect aquatic vegetation should be monitored as should the vegetation itself and the fish communities that use it.

All of these effects could be important in any of the NPS sites in the northeast. All parks are potentially affected by changing land use, changes in water quantity/quality, nutrient enrichment from urbanization and farming, and runoff from roads. At SAGA, special concerns are water quality, land use changes, and dam.

Future Work

A good effort was expended in sampling Saint-Gaudens NHS. Although, it is unlikely that any limited sampling will capture all species, especially, rare species, we think that we sampled a representative portion of the species. Electrofishing at flowing water index sites and a regular effort of nets and traps at ponds in Blow-Me-Down Pond should provide a good index of changes in species in these systems. Our recommendation is that the northeast parks band together and institute a sampling plan where they work together as a team to sample each park for fish every other year. Future efforts should be expended fine tuning the standardized effort of gear used and the target reference system for the park.

Results for Saratoga National Historical Park

Freshwater Habitat

Saratoga National Historical Park (SARA) contains 14 aquatic resources with freshwater fish (Figure 45). These resources consist of four habitat types: small lakes/low flow impoundments (Old Champlain Canal, Davidson Farm Pond, Burdyl Farm Pond, Vly Pond, Service Road Pond, Tour Road Pond, Culvert Pond, River Road Pond), lower gradient streams (Mill Creek- all three branches, Kroma Kill, Americans Creek, Devil's Hollow Creek), moderate gradient streams (Mill Creek- all three branches), and higher gradient streams (South Branch - Mill Creek, Kroma Kill, and Devil's Hollow Creek) (Figure 46). Note that some resources contained multiple habitat types. Low flow impoundments were defined as bodies of water with a man-made dam that form a small pond or lake with minimal inflow and outflow. Small ponds were similar systems but without a dam. Lower gradient streams were defined as slower moving, soft-bottomed systems with many large pools. Moderate gradient streams had faster moving, gravel and cobble bottomed systems with riffles and runs. Higher gradient streams were extremely fast moving systems with runs, falls, and plunge pools flowing over rock to boulder substrates. Defining habitat type is important for both the selection of effective sampling gear and to identify potential fish communities.

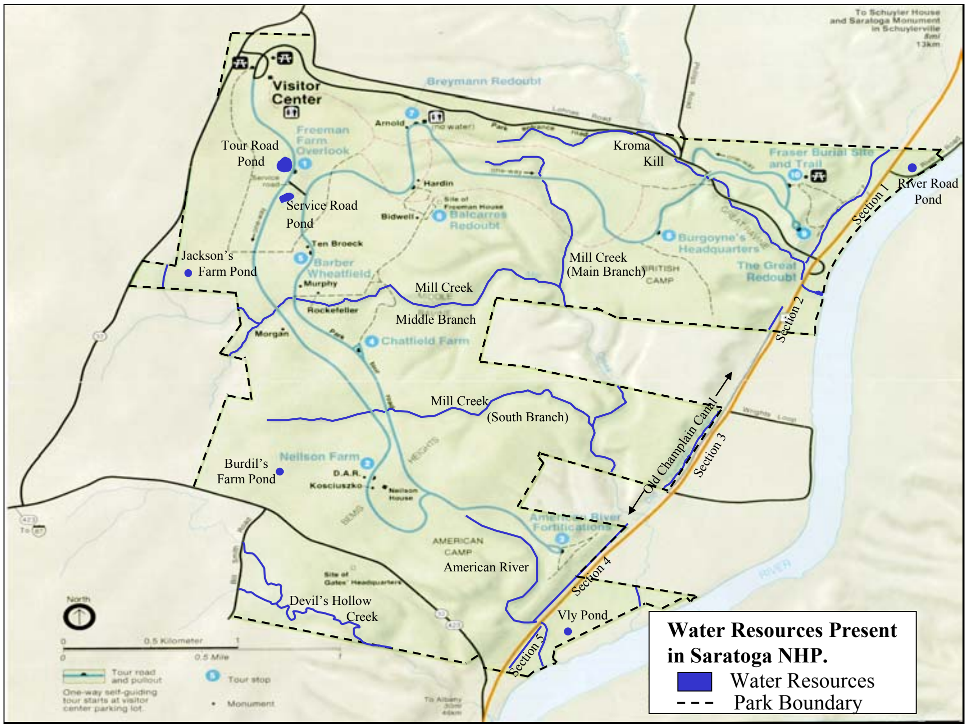

Figure 45. Water resources present at Saratoga NHP.

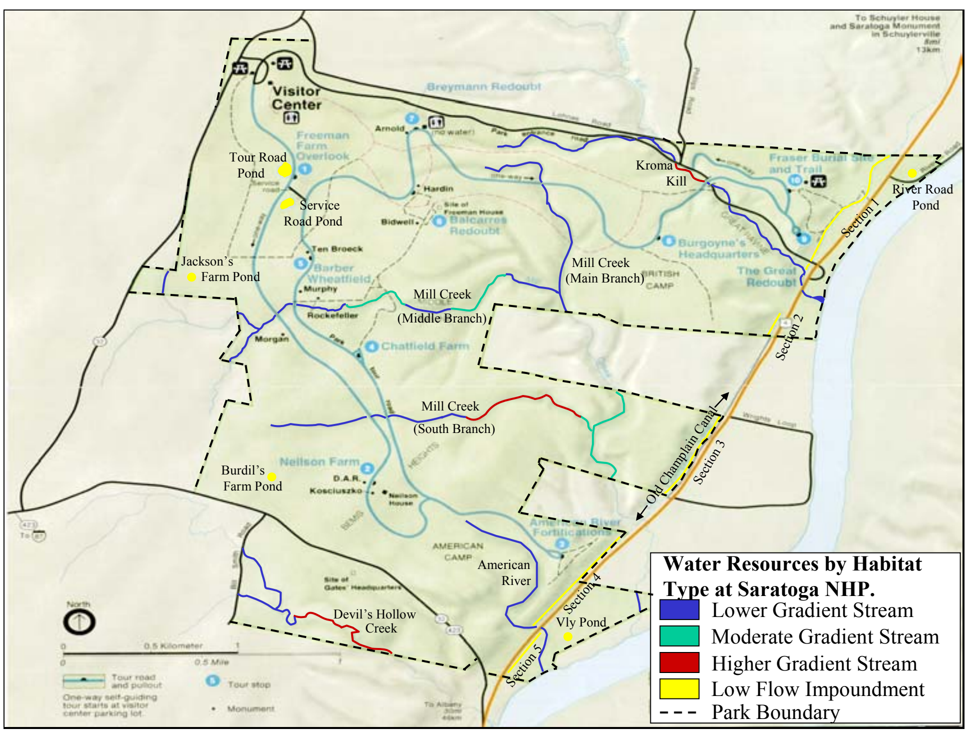

Figure 46. Water resources by habitat type at Saratoga NHP.

Sampling Intensity

Habitats at Saratoga were surveyed in October, 1999. This system was sampled for fish in October, 2000. We tried to sample habitat types with a standardized repetitive effort, i.e. (a) for standing water, repeated combinations of fyke nets, minnow traps, and, where possible, a trammel net and beach seine, and (b) for flowing waters, repeated electrofishing transects (Figure 47). However, sometimes the standard effort had to be modified because of system size, bottom type, or other constraints. In general, we sampled streams with a backpack electrofisher repeated over 25 m sampling transects until our catch curve flattened out, i.e., no or few new species caught or 10% of the habitat was sampled. In general, ponds and low flow impoundments were sampled with repetitions of 15 minnow traps and three fyke nets (Champlain Canal), although under certain conditions 1-2 fyke nets were set with 5-10 minnow traps (Champlain Canal, farm ponds). When the system was large enough (Champlain Canal), a trammel net was also used. At Saratoga, a beach seine was never used because of bottom conditions.

We sampled 8 of 14 aquatic resources. Twenty-five sites were sampled with 110 units of effort/pieces of gear (Figure 48). Specifically, 37 units of effort/gear were sampled at 11 stream habitat sites (Kroma Kill, Mill Creek, Americans Creek) using a backpack electrofisher. This sampling comprised 2-22% of the total flowing water habitat at Saratoga. During this same sampling period, the impoundment and small lake habitats were sampled at 14 sites representing 73 units of effort/gear. The low flow impoundment habitat (Champlain Canal) was sampled with the traditional standing water gear two times (3 fyke nets, 15 minnow traps, 1 trammel net = 6 sites and 32 units of effort/gear) and with a reduced suite of gear one time (1 fyke net, 6-9 minnow traps, 1 trammel net = 4 sites and 16 units of effort/gear). A more limited suite of gear was used to sample the smaller farm ponds i.e., 1-2 fyke nets and 5-10 minnow traps.

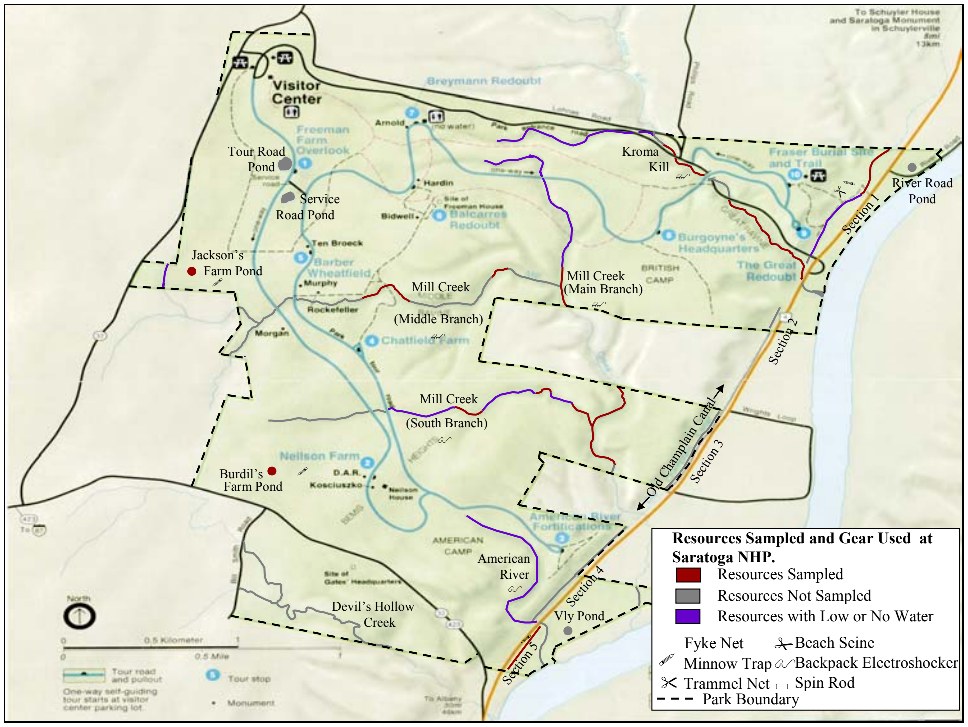

Figure 47. Resources sampled and gear used at Saratoga NHP.

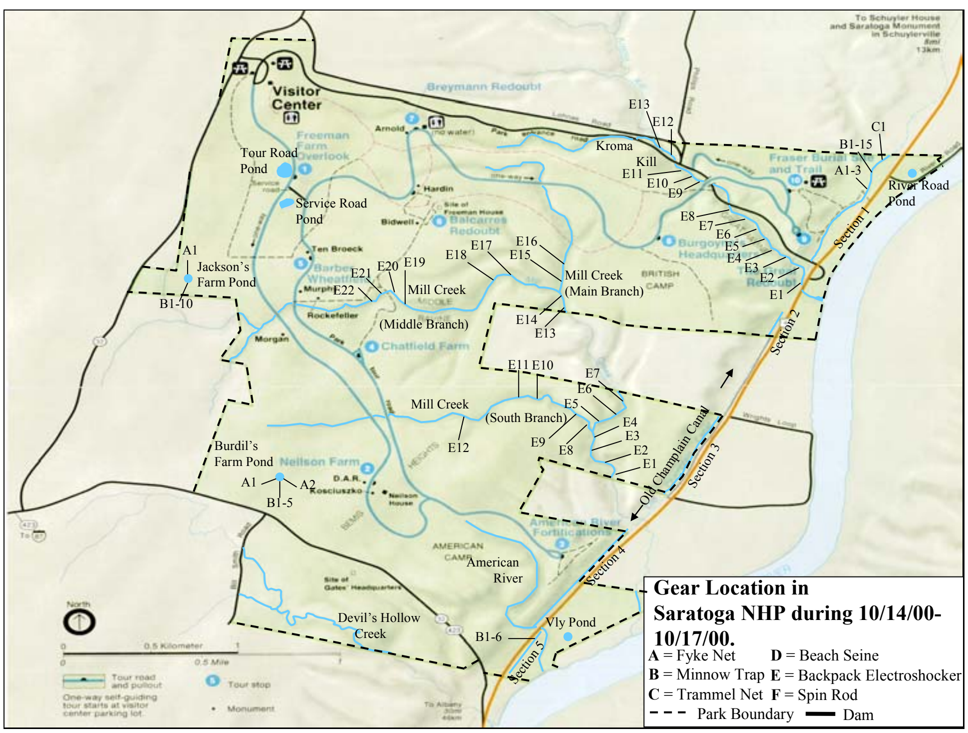

Figure 48. Gear location at Saratoga NHP.

The Fish community

Overall, Saratoga contained 13 freshwater fish species (blacknose dace, bluegill sunfish, brassy minnow, brown bullhead, central mudminnow, golden shiner, johnny darter, largemouth bass, longnose dace, pumpkinseed sunfish, spottail shiner, rosyface shiner, white sucker) from six families (Cyprinidae: blacknose dace, brassy minnow, golden shiner, longnose dace, spottail shiner, rosyface shiner; Centrarchidae: bluegill sunfish, largemouth bass, pumpkinseed sunfish; Ictaluridae: brown bullhead; Umbridae: central mudminnow; Percidae: Johnny darter; and Catastomidae: white sucker) (Figure 49). Of these, all but bluegill sunfish are native. Although bluegill did not evolve in these systems, bluegill have been in many northeastern systems for over a hundred years, are naturally reproducing, and are not generally thought of as a threat to native biodiversity.

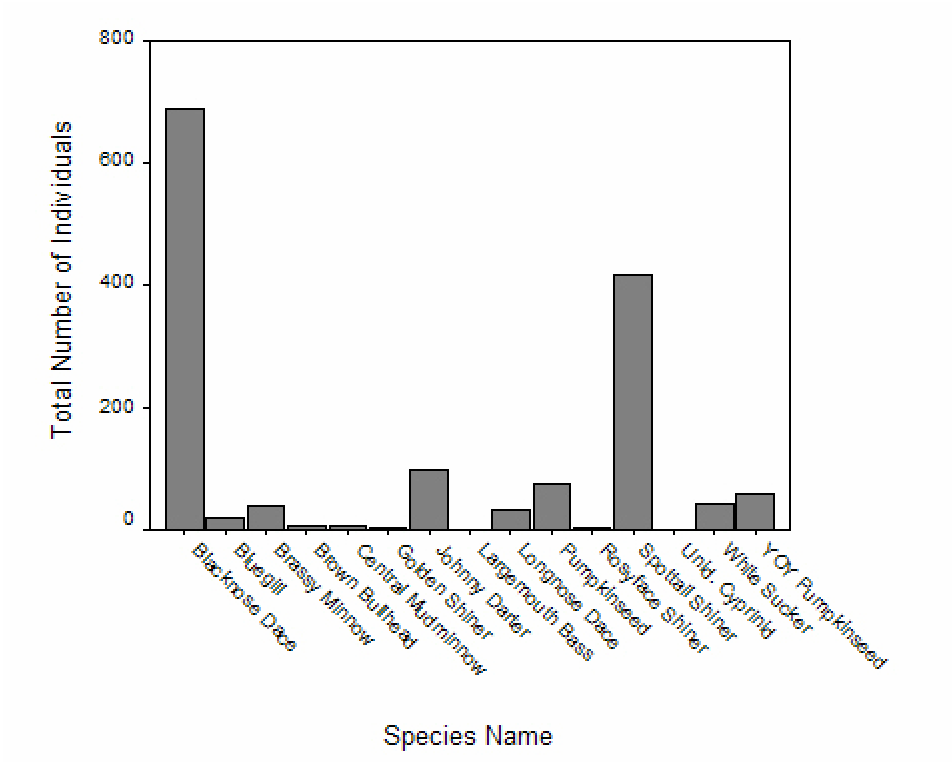

Figure 49. Species and total number of individuals detected at Saratoga NHP.

Summary

Blacknose dace, johnny darter, longnose dace, spottail shiner, rosyface shiner and white sucker are typical stream fish (Table 12). Their adaptations to living in flowing water include either a flattered body or an ecological affinity to shelter in the stream bottom/margin. All but the white sucker feed on invertebrates either on the bottom or in the drift. White suckers are omnivores consuming a wide variety of bottom materials. Blacknose dace are an extremely common stream fish and are considered tolerant of a wide variety of water conditions. Darters and suckers, on the other hand, are often considered to be characteristic of higher quality habitat conditions. Golden shiners are planktivores found in both lakes and streams although most often lakes. Bluegill sunfish typically are found in slow moving or standing water and typically consume plankton but will also eat small benthic invertebrates. The omnivorous brown bullhead is also typically found in slower water, mostly standing water, systems (Table 12). Pumpkinseed sunfish occupy both standing and flowing water systems. Largemouth bass most often occupy slow moving water. Central mudminnow are small-bodied benthic fish that are extremely tolerant of harsh abiotic conditions although they are poor competitors for benthic invertebrates (Table 12).

Table 12. Saratoga NHP sampling locations, habitat types, and number of species identified.

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
American River	Lower gradient stream	No Fish	0	0.00	.
		Not counted	0	0.00	.
Burdil's Farm Pond	Low flow impoundment	No Fish	0	0.00	0.00
Davidson's Farm Pond	Low flow impoundment	Brassy Minnow	38	19.00	25.46
		Brown Bullhead	3	3.00	.
		Pumpkinseed	61	30.50	34.65
		Spottail Shiner	27	27.00	.
		YOY Pumpkinseed	59	29.50	40.31
Kroma Kill	Higher gradient stream	Blacknose Dace	92	30.67	26.10
		Johnny Darter	3	1.50	0.71
		Longnose Dace	27	13.50	0.71
		Spottail Shiner	10	3.33	2.08
		White Sucker	5	2.50	0.71
	Lower gradient stream	Blacknose Dace	138	13.80	20.94
		Johnny Darter	91	9.10	3.70
		Longnose Dace	5	2.50	0.71
		Pumpkinseed	3	1.00	0.00
		Rosyface Shiner	2	2.00	.
		Spottail Shiner	89	8.90	12.43
		Unid. Cyprinid	1	1.00	.
		White Sucker	26	5.20	2.59
Mill Creek (Main Branch)	Lower gradient stream	Blacknose Dace	164	41.00	21.69
		Spottail Shiner	93	23.25	4.99
	Moderate gradient stream	Blacknose Dace	145	18.13	9.34
		Johnny Darter	3	1.00	0.00
		Spottail Shiner	52	7.43	4.43
		White Sucker	7	2.33	0.58
Mill Creek (Middle Branch)	Moderate gradient stream	Blacknose Dace	127	21.17	14.37
		Spottail Shiner	86	14.33	11.62
		White Sucker	2	2.00	.

Table 12. Saratoga NHP sampling locations, habitat types, and number of species identified (continued).

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
Mill Creek (South Branch)	Lower gradient stream	Blacknose Dace	5	5.00	.
		Spottail Shiner	22	22.00	.
	Moderate gradient stream	Blacknose Dace	19	6.33	6.11
		Spottail Shiner	36	12.00	5.20
Old Champlain Canal (sect. 1)	Low flow impoundment	Bluegill	19	2.38	1.77
		Brown Bullhead	2	1.00	0.00
		Golden Shiner	3	1.00	0.00
		Largemouth Bass	1	1.00	.
		No Fish	0	0.00	0.00
		Pumpkinseed	13	3.25	3.20
		White Sucker	3	1.00	0.00
Old Champlain Canal (sect. 5)	Low flow impoundment	Central Mudminnow	6	6.00	.
Total	Higher gradient stream	Blacknose Dace	92	30.67	26.10
		Johnny Darter	3	1.50	0.71
		Longnose Dace	27	13.50	0.71
		Spottail Shiner	10	3.33	2.08
		White Sucker	5	2.50	0.71
	Low flow impoundment	Bluegill	19	2.38	1.77
		Brassy Minnow	38	19.00	25.46
		Brown Bullhead	5	1.67	1.15
		Central Mudminnow	6	6.00	.
		Golden Shiner	3	1.00	0.00
		Largemouth Bass	1	1.00	.
		No Fish	0	0.00	0.00
		Pumpkinseed	74	12.33	21.08

Table 12. Saratoga NHP sampling locations, habitat types, and number of species identified (continued).

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Deviation
		Spottail Shiner	27	27.00	.
		White Sucker	3	1.00	0.00
		YOY Pumpkinseed	59	29.50	40.31
	Lower gradient stream	Blacknose Dace	307	20.47	23.49
		Johnny Darter	91	9.10	3.70
		Longnose Dace	5	2.50	0.71
		No Fish	0	0.00	.
		Not counted	0	0.00	.
		Pumpkinseed	3	1.00	0.00
		Rosyface Shiner	2	2.00	.
		Spottail Shiner	204	13.60	12.33
		Unid. Cyprinid	1	1.00	.
		White Sucker	26	5.20	2.59
	Moderate gradient stream	Blacknose Dace	291	17.12	11.66
		Johnny Darter	3	1.00	0.00
		Spottail Shiner	174	10.88	8.19
		White Sucker	9	2.25	0.50

Rosyface shiner were found only in low gradient streams. Blacknose dace and johnny darter were found in all three gradients of streams whereas longnose dace were found in both the low and high gradient streams. Bluegill sunfish, brassy minnow, brown bullhead, central mudminnow, golden shiner, and largemouth bass were found in all types of impoundments and ponds. Pumpkinseed were found in both low gradient impoundments and low gradient streams. Spottail shiner and white sucker were found in low flow impoundments and all gradients of stream. Across all habitats, blacknose dace and spottail shiner were extremely common and rosyface shiner were caught in low numbers (Table 12). None of the species at Saratoga are threatened, endangered, or of special concern.

These species cover a range of ecological roles. Golden shiners are obligate plantivores. Although bluegill can feed on an array of invertebrates, these small-mouthed fish preferentially consume zooplankton when available. A number of species including blacknose dace, brassy minnow, central mudminnow, johnny darter, longnose dace, pumpkinseed sunfish, spottail shiner, and rosyface shiner feed on invertebrates. Although these invertivores are all diet generalists, some species like pumpkinseed have morphological adaptations that allow them to thrive on benthos. Largemouth bass are piscivorous top predators. Brown bullhead and white sucker have omnivorous eating habits.

Previous records

Previous sampling records are useful to determine the potential species pool. However, less common and highly variable (but not necessarily rare/threatened/endangered) species may not be caught in every inventory effort because of variability and chance not because these species are decreasing in abundance. These less common and highly variable species often comprise a substantial portion of any animal community (i.e., this is the basis for the lognormal distribution of species often used in theoretical models). The catch of these less common and highly variable species is exacerbated by different sampling methodologies and levels of effort. Hence, it is difficult to draw conclusions about changes in freshwater fish communities from occasional surveys. This is why we recommend repeating the same type of sampling at the same sites at the same effort levels for several years to get a baseline species list. Once this is established, changes through time can be interpreted with increased confidence.

We compiled previous information on fish. Limited information is available on fish communities at SARA. The list of potential species is based on a general assessment and is quite different from what we found. We only found five species on the potential species list (bluegill, johnny darter, largemouth bass, pumpkinseed, and white sucker). Eight other potential species were not found. In addition, we found five species not on the potential species list. In our opinion, little useful information is gained from comparing our catches to this non-specific list. Again, getting a baseline species pool using standardized methods is recommended before any speculations are made about changes in species diversity.

Anthropogenic Effects

Land Use

A major source of anthropogenic effects are those associated with changing land use. As the amount of forest is decreased and as development and/or agriculture increase, a number of effects can occur that can have adverse effects on freshwater fish. First, as the amount of vegetation decreases, the hydrograph changes. Often more water flows over land and less percolates into the ground water. As a result, extreme flow conditions increase and both floods and droughts are exacerbated. This change in water quantity and especially the variation in water quality can have adverse effects on many fish. Second, roads and other paved areas will increase runoff. Third, a change in riparian corridor can have adverse effects on stream water quality. The resulting increased runoff from development, roads, and an altered riparian area can increase the amount of sediment, nutrients, salt, and car oil in the lakes and streams. A decrease in water quality can, of course, have an adverse effect on freshwater fish by affecting basic physiology/metabolism, increasing disease, and affecting spawning and egg development. Changes in land use should be monitored for the watershed in which the park resides. If land use changes, water quality, sediment, and incidence of disease should be monitored. Seasonal flow regimes should also be documented.

Contaminants

Contaminants from industry can have an adverse effect on fish physiology. In areas where contaminants are know to exist, water quality, contaminant loads, and fish communities should be carefully watched.

Animals that affect vegetation and water flow

Beaver and deer are increasing in many suburban/urban areas. Beaver, by damming streams, can slow/stop flow and change the community from a flowing system to a standing water one. Deer can overgraze riparian areas and cause increased sedimentation and runoff. If either of these animals is common in the area of the park, water quality, flow regime, and fish communities should be carefully monitored.

Dams

Dams are an integral part of many northeastern systems. If drawdown is planned to repair dams, care should be taken not to adversely affect those fish that live in the impoundment margin. This can be done by simply watching how much inshore substrate is dewatered by the drawdown. If possible, avoid drawdown in spring when sunfish are building nests in the shallows.

Stocking, Visitation, and Invading Species

Adding new species to any system can affect existing species. Often with increased human activity, species are transplanted between water bodies. Visitors should be warned about the dangers of this. Stocking should be relegated to tested programs. Monitoring fish species composition should alert the park to new species.

Vegetation

In many systems, aquatic vegetation is critical to fish community structure. Changes in vegetation could change the fish communities drastically. Changes in water quality, nutrients, and other factors that affect aquatic vegetation should be monitored as should the vegetation itself and the fish communities that use it.

All of these effects could be important in any of the NPS sites in the northeast. All parks are potentially affected by changing land use, changes in water quantity/quality, nutrient enrichment from urbanization and farming, and runoff from roads.

Future Work

A good effort was expended in sampling Saratoga NHP. This park has a substantial amount of aquatic habitat that covers a variety of habitats. Although, it is unlikely that any limited sampling will capture all species, especially, rare species, we think that we sampled a representative portion of the species. Electrofishing at flowing water index sites and a regular effort of nets and traps at ponds and the Champlain canal should provide a good index of changes in species in these systems. Our recommendation is that the northeast parks band together and institute a sampling plan where they work together as a team to sample each park for fish every other year. Future efforts should be expended fine tuning the standardized effort of gear used and the target reference system for the park.

Results for Weir Farm National Historic Site

Freshwater Habitat

Weir Farm National Historic Site (WEFA) contains one aquatic resource with freshwater fish (Figure 50). This resource, Weir Farm Pond, is a low flow impoundment or a body of water with a manmade dam that forms a small pond or lake (Figure 51). The inflow and outflow of this type of aquatic resource are minimal but still act as a source of immigration and emigration for fish and other aquatic organisms.

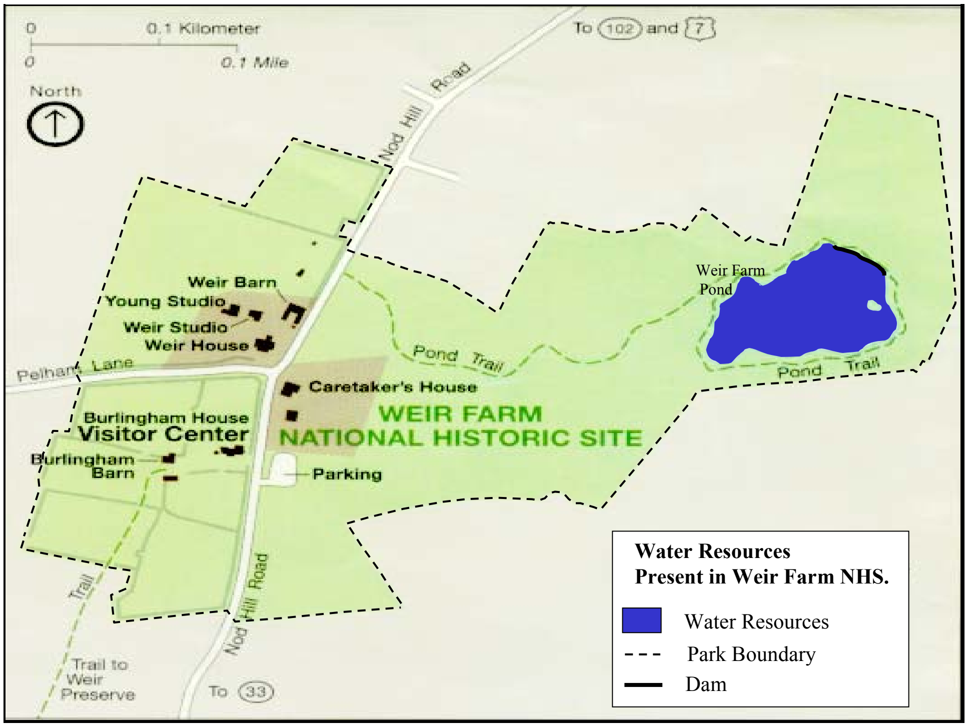

Figure 50. Water resources present at Weir Farm NHS.

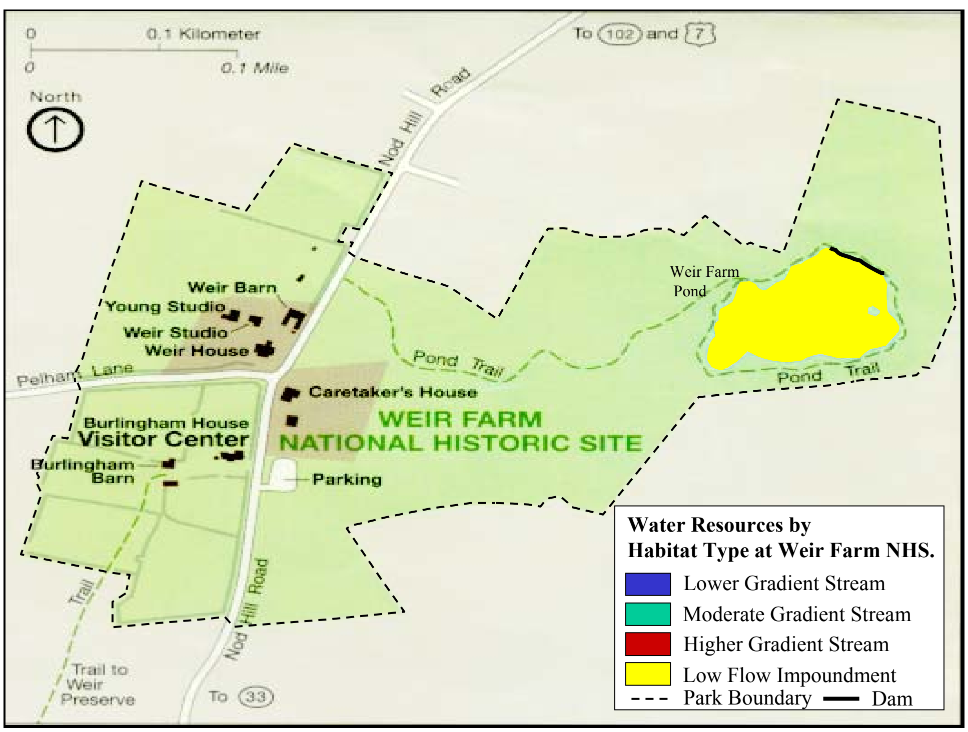

Figure 51. Water resources by habitat type at Weir Farm NHS.

Sampling Intensity

Habitats of Weir Farm were surveyed in October, 1999. This system was sampled for fish in September, 2000. During three days of sampling at this one resource, in 16 sites, 88 units of effort (or pieces of gear) were used to sample fish (Figure 52). Both day and night sampling were evaluated.

The littoral zone of the pond was sampled with the standard suite of gear used for small standing water systems set 3 times (3 fyke nets, 15 minnow traps 1 trammel net, @3 sites=19 units of gear) and a slightly more intensive suite of gear set one time (5 fyke nets, 15 minnow traps 1 trammel net ; @3 sites=21 units of gear) (Figure 53). To target the more difficult larger predators, spinning rods were used to angle while these nets/traps fished.

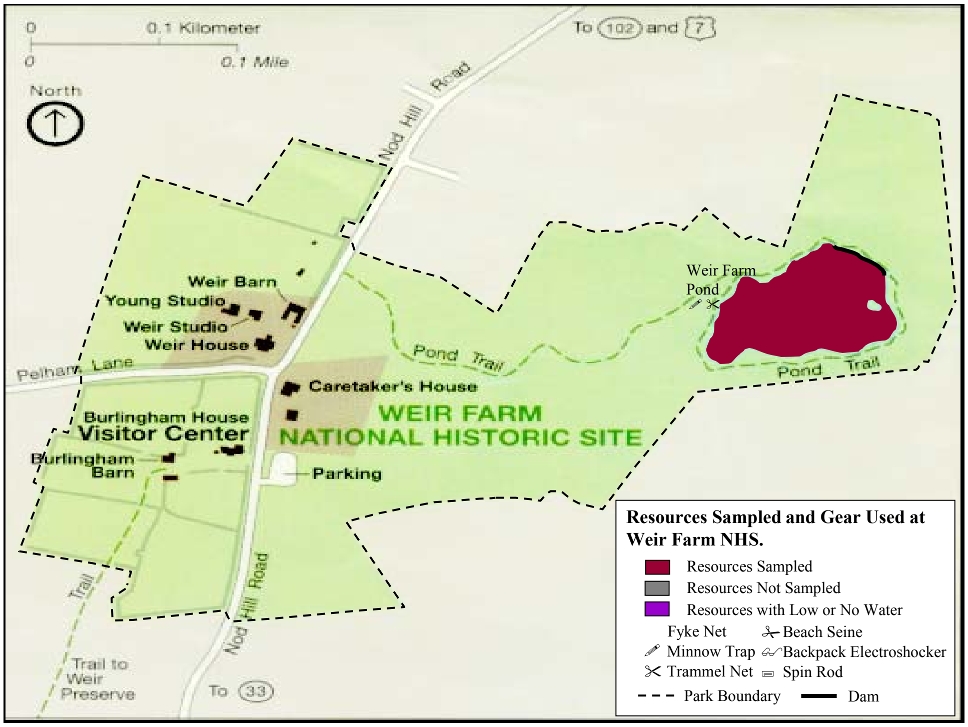

Figure 52. Resources sampled and gear used at Weir Farm NHS.

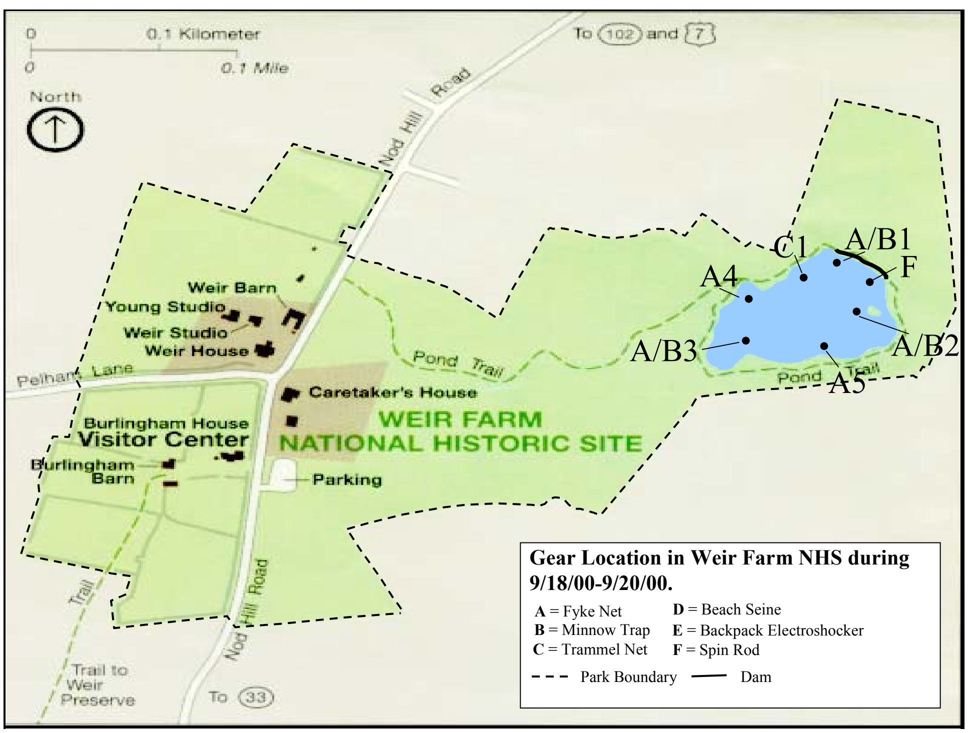

Figure 53. Gear location at Weir Farm NHS.

The Fish community

Weir Farm Pond contained three species: American eel, largemouth bass, and pumpkinseed sunfish belonging to 2 families: Anguillidae and Centrarchidae (Figure 54). Of these, two species, American eel and pumpkinseed sunfish, are native. Largemouth bass are not native but have been in many northeastern systems for over a hundred years, are naturally reproducing, and prized by recreational anglers.

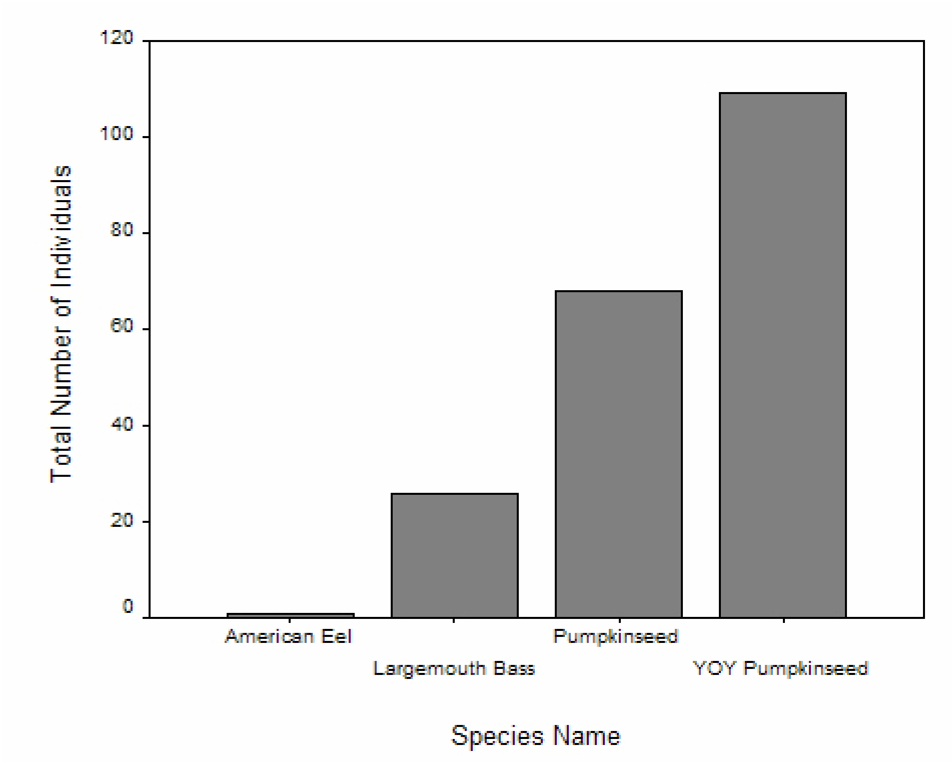

Figure 54. Species and total number of individuals detected at Weir Farm NHS.

American eel are an anadromous species and may come and go through the inflow and outflow. Eels are habitat and diet generalists consuming an array of food types. Both the pumpkinseed sunfish and the largemouth bass generally inhabit the inshore littoral zone and use shelter and vegetation both for foraging and to avoid predators. Both of these centrarchids are nest builders, that is, in the spring, the male fish build nests in the shallow inshore area, attract females, then guard the eggs until the young hatch. Hence, any change in water level in the spring can impact reproduction. Pumpkinseed sunfish consume benthic invertebrates whereas largemouth bass are piscivorous predators. Both of these centrarchids are considered desirable species and many small ponds contain this combination of sunfish (pumpkinseed) and predators (largemouth bass). With the exception of eel, species were abundant (Table 13). None of these species are threatened, endangered, or of special concern.

Table 13. Weir Farm NHS sampling locations, habitat types, and number of species identified.

Resource	Habitat	Species Name	Total Inds.	Mean	Std. Dev
Weir Pond	Low flow impoundment	American Eel	1	1.00	.
		Largemouth Bass	26	3.71	2.29
		Pumpkinseed	68	4.86	4.07
		YOY Pumpkinseed	109	12.11	11.16
Total	Low flow impoundment	American Eel	1	1.00	.
		Largemouth Bass	26	3.71	2.29
		Pumpkinseed	68	4.86	4.07
		YOY Pumpkinseed	109	12.11	11.16

Summary

Weir Pond seems like a healthy system with natural reproduction and should be maintained. Although there are only three species, this is normal diversity for such a small system. Because J. Alden Weir was an avid fisherman and stocked the pond for fishing, as was common in his day, maintaining largemouth bass and their prey, pumpkinseed sunfish, should be a priority for the park.

Previous records

Previous sampling records are useful to determine the potential species pool. However, less common and highly variable (but not necessarily rare) species may not be caught in every inventory effort because of heterogeneity and chance not because these species are decreasing in abundance. These less common and highly variable species often comprise a substantial portion of any animal community (i.e., this is the basis for the lognormal distribution of species often used in theoretical models). The catch of these less common and highly variable species is exacerbated by different sampling methodologies and levels of effort. Hence, it is difficult to draw conclusions about changes in freshwater fish communities from occasional surveys. This is why we recommend repeating the same type of sampling at the same sites at the same effort levels for several years to get a baseline species list. Once this is established, changes through time can be interpreted with increased confidence. No formal surveys have documented fish communities at WEFA in the past so no useful evaluation of change in fish communities is possible. The list of potential species is based on a general regional key and is much broader than what is realistically expected.

Anthropogenic Effects

Land Use

A major source of anthropogenic effects are those associated with changing land use. As the amount of forest is decreased and as development and/or agriculture increase, a number of effects can occur that can have adverse effects on freshwater fish. First, as the amount of vegetation decreases, the hydrograph changes. Often more water flows over land and less percolates into the ground water. As a result, extreme flow conditions increase and both floods and droughts are exacerbated. This change in water quantity and especially the variation in water quality can have adverse effects on many fish. Second, roads and other paved areas will increase runoff. Third, a change in riparian corridor can have adverse effects on stream water quality. The resulting increased runoff from development, roads, and an altered riparian area can increase the amount of sediment, nutrients, salt, and car oil in the lakes and streams. A decrease in water quality can, of course, have an adverse effect on freshwater fish by affecting basic physiology/metabolism, increasing disease, and affecting spawning and egg development. Changes in land use should be monitored for the watershed in which the park resides. If land use changes, water quality, sediment, and incidence of disease should be monitored. Seasonal flow regimes should also be documented.

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Dams are an integral part of many northeastern systems. If drawdown is planned to repair dams, care should be taken not to adversely affect those fish that live in the impoundment margin. This can be done by simply watching how much inshore substrate is dewatered by the drawdown. If possible, avoid drawdown in spring when sunfish are building nests in the shallows.

Stocking, Visitation, and Invading Species

Adding new species to any system can affect the existing community. Often with increased human activity, species are transplanted between water bodies. Visitors should be warned about the dangers of this. Stocking should be relegated to tested programs. Monitoring fish species composition should alert the park to new species.

Vegetation

In many systems, aquatic vegetation is critical to fish community structure. Changes in vegetation could change the fish communities drastically. Changes in water quality, nutrients, and other factors that affect aquatic vegetation should be monitored as should the vegetation itself and the fish communities that use it.

All of these effects could be important in any of the NPS sites in the northeast. All parks are potentially affected by changing land use, changes in water quantity/quality, nutrient enrichment from urbanization and farming, and runoff from roads. At Weir Farm special concerns are water quality, land use, and dam-related issues.

Future Work

Because this was one of the first systems sampled, we expended excessive effort to make sure the gear sampled effectively and that the sampling regime was rigorous. Although predators are harder to sample as are rare species, one set of gear (fyke net, minnow traps, and trammel nets) rather than four would probably suffice as an index of species present. Our recommendation is that the northeast parks band together and institute a sampling plan where they work together as a team to sample each park for fish every other year. Future efforts should be expended fine tuning the standardized effort of gear used and the target reference system for the park.

As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-22 August 2005

National Park Service
U.S. Department of the Interior

Northeast Region
Inventory & Monitoring Program
Northeast Temperate Network
54 Elm Street
Woodstock, Vermont 05091

http://www1.nature.nps.gov/im/units/netn/index.cfm